NEW SERIES

# SELECTED

# **ESOURCES**ABSTRACTS



VOLUME 2, NUMBER 4 FEBRUARY 15, 1969

## NEW SERIES

Selected Water Resources Abstracts is published semimonthly for the Water Resources Scientific Information Center (WRSIC) by the Clearinghouse for Federal Scientific and Technical Information (CFSTI) of the Bureau of Standards, U. S. Department of Commerce. It is available to Federal agencies, contractors, or grantees in water resources upon request to: Manager, Water Resources Scientific Information Center, Office of Water Resources Research, U. S. Department of the Interior, Washington, D. C. 20240. Annual subscription is \$22.00 (domestic), \$27.50 (foreign); single copy price is \$3.00.



## SELECTED

## WATER RESOURCES ABSTRACTS

A Semimonthly Publication of the Water Resources Scientific Information Center, Office of Water Resources Research, U.S. Department of the Interior



VOLUME 2, NUMBER 4 FEBRUARY 15, 1969

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As the Nation's principal conservation agency, the Department of the Interior has basic responsibilities for water, fish, wildlife, mineral, land, park, and recreational resources. Indian and Territorial affairs are other major concerns of America's "Department of Natural Resources."

The Department works to assure the wisest choice in managing all our resources so each will make its full contribution to a better United States--now and in the future.

#### FOREWORD

**Selected Water Resources Abstracts,** a semimonthly journal, includes abstracts of current and earlier pertinent monographs, journal articles, reports, and other publication formats. The contents of these documents cover the water-related aspects of the life, physical, and social sciences as well as related engineering and legal aspects of the characteristics, conservation, control, use, or management of water. Each abstract includes a full bibliographical citation and a set of descriptors or identifers which are listed in the **Water Resources Thesaurus** (November 1966 edition). Each abstract entry is classified into ten fields and sixty groups similar to the water resources research categories established by the Committee on Water Resources Research of the Federal Council for Science and Technology.

Sufficient bibliographic information is given to enable readers to order the desired documents from local libraries or other sources. WRSIC is not presently prepared to furnish loan or retention copies of the publications announced.

**Selected Water Resources Abstracts** is designed to serve the scientific and technical information needs of scientists, engineers, and managers as one of several planned services of the Water Resources Scientific Information Center (WRSIC). The Center was established by the Secretary of the Interior and has been designated by the Federal Council for Science and Technology to serve the water resources community by improving the communication of water-related research results. The Center is pursuing this objective by coordinating and supplementing the existing scientific and technical information activities associated with active research and investigation program in water resources.

To provide WRSIC with input, selected organizations with active water resources research programs are supported as "centers of competence" responsible for selecting, abstracting, and indexing from the current and earlier pertinent literature in specified subject areas. Centers, and their subject coverage, now in operation are:

- Ground and surface water hydrology at the Water Resources Division of the U.S. Geological Survey, U.S. Department of the Interior.
- Metropolitan water resources management at the Center for Urban Studies of the University of Chicago.
- Eastern United States water law at the College of Law of the University of Florida.
- Policy models of water resources systems at the Department of Water Resources Engineering of Cornell University.
- Water resources economics at the Water Resources Research Institute of Rutgers University.
- Design and construction of hydraulic structures; weather modification; and evaporation control at the Bureau of Reclamation, Denver, Colorado.
- Eutrophication at the Water Resources Center of the University of Wisconsin.
- Water resources of arid lands at the Office of Arid Lands Studies of the University of Arizona.

The input from these Centers, and from the 51 Water Resources Research Institutes administered under the Water Resources Research Act of 1964, as well as input from the grantees and contractors of the Office of Water Resources Research and other Federal water resources agencies with which the Center has agreements becomes the information base from which this journal is, and other information services will be, derived; these services include bibliographies, specialized indexes, literature searches, and state-of-the-art reviews.

Comments and suggestions concerning the contents and arrangement of this bulletin are welcome.

Water Resources Scientific
Information Center
Office of Water Resources Research
U.S. Department of the Interior
Washington, D. C. 20240

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#### SELECTED WATER RESOURCES ABSTRACTS

#### 02. WATER CYCLE

#### 2A. General

#### AN INVESTIGATION INTO THE RELATION-SHIP BETWEEN METEOROLOGICAL VARIA-BLES AND STREAMFLOW.

Rutgers University, New Brunswick, N. J. College of Agriculture and Environmental Science.

Joseph L. Horowitz, and Mark D. Shulman. Water Resour Bull, AWRA, Vol 3, No 3, pp 21-31, Sept 1967. 11 p, 6 fig, 3 tab, 4 ref. OWRR Project A-002-NJ.

Descriptors: \*Synthetic hydrology, Streamflow, Runoff, New Jersey, Statistical models, Low flow, Base flow, Drought.

Identifiers: \*Thornthwaite method.

Analyses are presented relating streamflow and meteorological variables. In one approach a physical model was developed and yielded a correlation coefficient of .857 between streamflow and Thomthwaite runoff. The resulting linear regression equation had a standard error of 37.10 cfs and could be used to develop a synthetic streamflow sequence with best results during low flow situations. A second approach used a linear stepwise multiple regression analysis to relate streamflow and monthly values of antecedent precipitation and Palmer runoff. This model yielded an equation with six predictors and a multiple correlation coefficient of .877 and a standard error of 35.21 cfs. The first approach is preferred in that the comparative loss in the reduction of variance is outweighed by the simplicity of the method. (Shulman-Rutgers)

#### ANALYSIS OF OVERLAND FLOW ON SHORT EROSION PLOTS,

Purdue Univ, Lafayette, Indiana.

George R. Foster.

Part of OWRR Project B-003-IND: 'Mathematical Simulation of Hydrologic Events on ungaged Watersheds', 1968. Master of Science Thesis, Department of Agricultural Engineering, Purdue University, 1968. 138 p, 43 fig, 5 tab, 4 append.

Descriptors: \*Erosion, \*Sedimentation, \*Overland flow, Runoff, Reynolds number, Chezy equation, Retention storage, Infiltration, Manning's equation, Roughness, Surface profiles, \*Agricultural watersheds, Runoff coefficient, Hydrograph analysis.

Identifiers: Coefficient of friction.

An analytical overland flow model of a watershed runoff hydrograph is proposed that satisfactorily predicts runoff for short agricultural slopes. The developed model is a kinematic model that mathematically is the combination of the continuity equation and the Chezy uniform flow relationship. The model includes retention storage, provisions for a variable point infiltration rate and a variable coeffi-cient of friction, the 'drying up' of the upstream end of the slope during recession and a variable area infiltration rate that is a function of the water surface area during recession. An implicit finite difference scheme is used to evaluate the continuity equation, and the model is programmed in FOR-TRAN IV for numerical evaluation on a digital computer. Field hydrographs from fallow erosion study plots were analyzed for retention storage and predicted coefficients of friction. These results were used in the model to simulate hydrographs which were compared with field hydrographs to test concepts used in the model. The model with a constant coefficient of friction or Manning's 'n adequately describe overland flow on short agricultural slopes. (Author) W69-01408

#### AQUIFER AND MODELS,

U. S. Geological Survey, Albuquerque, N. Mex. For primary bibliographic entry see Field 02F. For abstract, see . W69-01443

## AN EVALUATION OF THE INFLOW-RUNOFF RELATIONSHIPS IN HYDROLOGIC STUDIES, J. Amorocho, and G. T. Orlob.

Univ. Calif, Wat Resour Center Contrib No 41, 1961. 70 pp.

Descriptors: \*Rainfall-runoff relationships, \*Model studies.

Studies have been carried out by the University of California to establish some of the criteria required for the interpretation of statistical analyses of the relation between rainfall and run-off. For this purpose, a model of an hydrological unit was developed, based on a qualitative analysis of its fundamental functional elements, and its structure was compared with that of a typical regression equation. The conditions for minimum error in the estimates of flow from catchments were examined and various watersheds in different parts of the world were investigated to test the applicability of the equations of state developed. The advantages of using an equation of state for hydrologic studies in preference to wholly empirical relations derived from more or less arbitrary multiple correlation analyses are indicated.

## STEPS TOWARD A BETTER UNDERSTANDING OF URBAN RUNOFF PROCESSES,

Water Resources Res, Vol 4, No 2, p 335, April 1968.

Descriptors: \*Rainfall-runoff relationships, Drainage systems, Surface runoff, \*Storm runoff, Groundwater.

Rainfall and runoff from drainage basins in various stages of urbanization were analyzed to determine the initial retention, the hydrologically significant impermeable area, and the infiltration capacities of the permeable portions of the basins. The drainage basins, varying in size from 9.5 to 185 square miles, are located in the Detroit metropolitan area. Techniques were developed that largely eliminated personal judgment in separating surface runoff from ground water discharge. Infiltration capacities in this region are from 3 to 5 times higher in late summer than in early spring. The average initial retention for the basins studied is approximately 0.2 inch. The hydrologically significant impermeable area appears to be closely related to the population density, but the effect of other factors is being stu-died. An investigation of the cause of seasonal and short period variations of infiltration capacity may provide a better understanding of the infiltration process. W69-01563

#### COMPUTATION OF OPTIMUM REALIZABLE UNIT HYDROGRAPHS,

Peter S. Eagleson, Ricardo Mejia-R, and Frederic March.

Water Resources Res, Vol 2, No 4, pp 755-764, 1966. 6 fig, 22 ref.

Descriptors: \*Rainfall-runoff relationships, \*Computer programs.

Identifiers: Calculations, \*Urban hydrology.

The Wiener-Hopf theory of optimum linear systems is applied to the determination of the stable pulse response of a monotone hydrologic system from coincident records of input and output in the form of discrete time series. In application to the rainfall-runoff system, linear programming methods are used in the solution of the Wiener-Hopf equations to obtain physically realizable unit hydrographs. An actual urban rainfall-runoff event is graphed and used for illustration in developing the equation.

W69-01567

## SCALE MODEL OF URBAN RUNOFF FROM STORM RAINFALL, R. A. Grace, and P. S. Eagleson.

ASCE Proc, J Hydraulics Div, Vol 93, No HY3, pp 161-176, May 1967.

Descriptors: Storms, \*Model studies, Storm runoff. Identifiers: \*Urban drainage.

The response of a small urban watershed to four storms is generated in the laboratory by a scale model consisting of a programmed rainfall generator, vertically-distorted scaled topography, and a weighing device for recording the cumulative runoff. Comparison of these results with prototype measurements through use of derived scaling laws shows reasonable agreement.

W69-01570

#### ON STRUCTURE OF COAXIAL GRAPHICAL RAINFALL-RUNOFF RELATIONS,

A. Becker.

Int. Assn Sci Hydrology-Bul, Vol 11, No 2, pp 121-30, June 1966.

Descriptors: \*Rainfall-runoff relationships, \*Rainfall intensity.

This paper, supported by investigations into extreme conditions and events--i.e., moisture-over-saturated river basin, threshold concept, instantaneous rainfall and rainfall of extreme amount-supplies general information on structure of coaxial graphical rainfall-runoff relations and on physical laws primarily controlling shape of curves in individual quadrants of coaxial relations. W69-01575

## CONCEPTION OF A MODEL FOR DETERMINING THE LAWS OF RAIN DISCHARGE RELATIONS .

A. Becker.

Wasserwirtsch-Wassertech, Vol 18, No 1, pp 16-21, Jan 1968.

Descriptors: \*Model studies, \*Rainfall-runoff relationships, Flow measurement, \*Surface runoff, Runoff forecasting.

Rain discharge relations, especially on the surface of rivers, play a significant role in the forecasting of floods, because they make it possible to achieve a maximum time advance in making the forecasts. A model is developed (based on unit territorial and rain relations) to deduce the rain discharge relationships from threshold values and other simple quantities. An example is given for which - on the basis of favorable conditions - an approximate determination of the surface water retention was possible by considering the surface water states at two representative measuring stations.

## SURVEY OF RECENT DEVELOPMENTS IN RAINFALL-RUNOFF ESTIMATION,

F. C. Bell.

Instn Engrs, Australia-J, Vol 38, No 3, pp 37-47, March 1966.

Descriptors: Rainfall intensity, \*Computer programs, \*Rainfall-runoff relationships, \*Model studies.

Advances in estimating streamflow from given quantities of rainfall that were made by simulating hydrological phenomena with high-speed computers are surveyed; it is shown that some of these techniques are based on rather artificial models of physical processes and could give poor predictions for extreme or uncommon conditions; individual processes are studied and it is suggested that most models could be improved.

W69-01577

## A MATHEMATICAL MODEL FOR RELATING RUN-OFF TO RAINFALL WITH DAILY DATA,

W. C. Boughton.

Civ Eng Trans, Inst Engrs Australia, Vol CE8, No 1, pp 83-97, 1966.

#### Group 2A-General

Descriptors: \*Model studies, \*Rainfall-runoff relationships, Rain gages.

The author describes the development and use of a mathematical model to simulate the changes of moisture in a catchment using daily rainfalls and evaporation records as data; the principal physical processes reproduced in the model, namely, evapotranspiration losses, soil moisture storage, and infiltration losses, are discussed. The model has been used with records from 6 gauged catchments in New South Wales, and showed reasonable correlation between recorded and estimated run-offs; the results also suggested a possible explanation of the difference in infiltration rates between plot experiments and natural catchments.

## RAINFALL-RUN-OFF RELATIONS IN THE UPPER GOULBURN RIVER CATCHMENT, N.S.W.,

T. G. Chapman.

Civ Eng Trans, Inst Engrs, Vol CE5, pp 25-35, Aug 1963.

Descriptors: \*Rainfall-runoff relationships, \*Rain gages, \*Storm runoff, \*Groundwater recharge, \*Rainfall intensity. Identifiers: \*Calculations.

The author describes the methods developed to determine the relation between rainfall and run-off in the Upper Goulburn river catchment in New South Wales, a large catchment for which records of stream flow and daily rainfall were available but there were no data on rainfall intensity. The network of official rain gauges was supplemented by records from privately-operated instruments; these had a slightly lower standard of consistency but were of adequate quality for use in the analysis. Linear regression techniques were used to estimate mean winter and summer rainfalls for each station for a common 50-year period; isohyetal maps for mean seasonal rainfalls were then developed by correlating the estimated rainfall for each station with its altitude and a third variable dependent on topography or location. About 75 per cent of the variation in rainfall was accounted for in this way, compared with 37 per cent when altitude was the only variable. The stream-flow record was used to estimate, within wide limits, the mean annual recharge to ground water and to calculate the direct run-off from 242 storms in 47 years. The relation between rainfall and run-off was developed by multiple regression analysis, which was first used to compare the efficiency of different predictors of rainfall intensity and catchment dryness. W69-01583

#### LABORATORY STUDY OF WATERSHED HYDROLOGY,

V. T. Chow.

Paper, Int Hydrol Symp, Fort Collins, Colo, Sept 1967, U of Illinois, Urbana. 14 p, 3 fig, 7 ref.

Descriptors: \*Rainfall-runoff relationships, \*Watersheds, \*Storm runoff, \*Model studies, \*Computer programs, \*Roughness (Hydraulic), Discharge (Water).

A conventional approach to study the rainfall-runoff relationship of a watershed uses historical hydrologic data to fit a black-box model for simulation of watershed hydrologic behavior. Although many measurements of rainfall input and runoff output from watersheds are available, no general theory explaining the course of flow mechanics from input to output exists. The proposed laboratory approach investigates basic laws and principles controlling mechanics of runoff from a watershed. It employs a watershed experimentation system (WES) as a tool for the research. The WES is an instrumentation system of integrated hydraulic, electronic, and structural design that can produce an artificial rainfall of variable time and space distribution to move over a laboratory area of 40 by 40 ft or less; thus, it is capable of simulating a storm moving in any direction over a testing drainage

basin constructed within the area. The experiment is controlled electronically by a digital computer, and output runoff is measured by sonar detectors which transmit information to the computer for immediate recording and analysis. Various problems being studied include the time factor in runoff process, conceptual watershed roughness, and effect of storm movement on peak discharges. The WES also may be used to study subsurface runoff by employing testing basins made of porous materials.

W69-01584

## SEQUENTIAL GENERATION OF RAINFALL AND RUNOFF DATA,

V. T. Chow, and S. Ramaseshan.
ASCE Proc, J Hydr Div, Vol 91, No HY 4, Pt 1, paper 4416, pp 205-23, July 1965.

Descriptors: \*Storm runoff, \*Drainage systems, \*Rainfall-runoff relationships. Identifiers: \*Calculations.

Practical procedure is demonstrated by applying sequential generation techniques to rainfall and runoff data for stochastic, hydrological analysis of drainage basin systems; in this method, stochastic process is formulated by several major components including hourly annual storm rainfalls, abstractions, routing model, baseflow, direct runoff, and total runoff: 1000 annual storms are generated sequentially by Monte Carlo methods and then routed through simulated basin system to produce 1000 generated floods which are represented by stochastic flow-duration curves for use in water resources planning and design.

#### CONCEPTUAL MODEL OF HYDROLOGIC CY-

N. H. Crawford, and R. K. Linsley. Int Geodetic and Geophysical Union-Soc for Sci Hydrology Pub, No 63, pp 573-87, 1964.

Descriptors: \*Model studies, \*Watersheds, \*Hydrographs, Groundwater, \*Storm runoff, Rainfall-runoff relationships, \*Computer programs.

Model called Stanford Watershed Model (Mark II) utilizes hourly ordinates of hydrograph during and immediately after rain and mean daily ordinates for interim periods; print-out includes monthly and annual flow, monthly groundwater runoff, end of month soil moisture, and flow duration curve of daily runoff; model includes among its components surface, interflow, and groundwater runoff; model has been tested on basins embracing variety of climate, hydrologic, and geologic conditions. W69-01586

#### LIMITING FACTORS IN RAINFALL RUN-OFF, L. B. Escritt.

Engr, London, Vol 213, 1962.

Descriptors: \*Rainfall-runoff relationships, \*Storm runoff, Storms, \*Rainfall intensity, Design, Sewage treatment, \*Runoff forecasting. Identifiers: \*Surface permeability.

When sewerage systems are being designed, the volume of storm water is often over-estimated because no allowance is made for change of impermeability during rainfall. In addition, in large catchment areas, heavy storms frequently cover only part of the total catchment, and when run-off is calculated by relating statistics of frequency, intensity and duration of rainfall to impermeable area by a time-of-concentration method, the flow may be considerably over-estimated. The author suggests methods for allowing for the change of impermeability during rainfall and for assessing the maximum areas likely to be covered by storms.

## RAINFALLS OF SHORT DURATION AND HIGH INTENSITY: AN ALTERNATIVE TO BILHAM'S FORMULA,

L. B. Escritt.

Water Waste Treatment J, Vol 7, 1960.

Descriptors: \*Rainfall intensity, Design, \*Surface runoff, \*Sewers. Identifiers: \*Storm sewers.

In connection with the design of surface water sewers, the author discusses the use of Bilham's formula for rainfalls of short duration and high intensity, and presents a modified general intensity formula derived from logarithmic plotting based on Bilham's formula. W69-01590

## COMPUTING RUNOFF FROM SMALL WATERSHEDS,

C. L. Hamilton.

Pub Works, Vol 96, No 8, pp 106-8, Aug 1965.

Descriptors: \*Storm runoff, \*Rainfall intensity, Watersheds. Identifiers: \*Calculations.

Use of summation 'W' method for estimating runoff from small watersheds, with 'W' standing for relative valves of certain physical watershed characteristics that are summed up to obtain preliminary estimate of peak discharge; rainfall factor was developed to make adjustment in rainfall intensity as it varies throughout United States in reference to intensity chosen as standard; sample computation is presented to illustrate application of method; data on runoff-producing characteristics of watershed with corresponding weights. W69-01593

#### 2B. Precipitation

#### CALIFORNIA HIGH WATER, 1965-1966.

California, Dept Water Resources-Bul 66-69, Aug 1967. 61 p.

Descriptors: Rainfall-runoff relationships, Precipitation intensity, \*Storm runoff, Storms. Identifiers: California.

This report provides information on meteorology, rainfall-runoff, and damages resulting from major storms of 1965-66 water year; it describes general weather patterns preceding and during storm periods, including precipitation characteristics and discusses resulting runoff in seven hydrograph areas of state; it presents information on flooded areas and damages; two storms during Nov 1965 recorded total of 30 in. of precipitation and one-day maximum of 12.4 in. at station in Santa Ana River Basin.

## TIME ANALYSIS OF RAINFALL ON URBAN CATCHMENT,

V. J. Bidwell.

J Hydrology, New Zealand, Vol 6, No 2, pp 74-9, 1967.

Descriptors: \*Rainfall intensity, \*Computer programs, Rain gages. Identifiers: \*Urban drainage, \*New Zealand.

Analysis of short-time-increment rainfall at University of Auckland in New Zealand; autocorrelation techniques proposed by R. A. Grace and P. S. Eagleson were used; practical methods of data recording and processing, suitable for digital computer analysis, are outlined; autocorrelation results are given for 1 yr of 10-min rainfall values for Albert Park gage at Auckland.

#### Streamflow and Runoff—Group 2E

RELATION OF ANNUAL RUNOFF TO METEOROLOGICAL FACTORS, M. W. Busby.

U S Geol Survey-Prof Paper 501-C, p C188-9,

Descriptors: Runoff, \*Runoff forecasting, Rainfallrunoff relationships

Average annual runoff at 62 selected stations throughout conterminous United States was related to nine meteorological factors as recorded at U S Weather Bureau first-order weather station near each point of runoff study; seven of these factors were significant at 80% level or higher; on basis of these seven factors, standard error of estimate of average annual runoff is about 30%. W69-01582

#### 2C. Snow, Ice, **AND Frost**

EFFECT OF SNOW COMPACTION ON RU-NOFF FROM RAIN OR SNOW,

F. A. Bertle.

U S Bur Reclamation-Eng Monographs, No 35, June 1966, 45 p.

Descriptors: \*Runoff, \*Snowmelt, Design storm, \*Rain

Computational procedure for determining water available for runoff and its time of occurrence resulting from rain-on-fresh-snow condition; procedure includes estimate of shrinkage of snow pack caused by metamorphosis of crystalline structure with addition of rainfall; examples are given showing use of procedure with assumed design storm conditions; procedure is used to reproduce observed flood which verifies accuracy of method and assumptions and is intended for use in inflow design flood study in which design rain occurs on fresh snowpack. W69-01578

#### DETERMINATION OF THE MELT-WATER FLOW FROM THE WATER RESOURCES OF THE SNOW COVER,

H. J. Grasnick

Wasserwirtsch-Wassertech, Vol 17, No 9, pp 302-306, Sept 1967.

Descriptors: \*Snowmelt, \*Runoff. Identifiers: \*Calculations.

With the aid of several statistical methods, an attempt was made to work out a prognosis for the melt-water run-off (as well as the total run-off at peak values) in some river areas of the German Democratic Republic showing various physical and geographical conditions. The investigation made use only of observation data published in the meteorological and hydrological annuals. Although this material, especially that about the snow cover, did not permit the desired fully complex statistical evaluation, nevertheless, it was possible to find certain regularities in the relationship between the water resource and run-off. The report contains results of a differential analysis of special snow investigations carried out in Spring 1965 and the author's suggestions on how to improve observation of the snow cover. W69-01592

#### 2D. Evaporation and **Transpiration**

WATER REQUIREMENTS FOR INCREASED ARID LAND PRODUCTIVITY, George H. Hargreaves.

Agency for International Development; Centro Interamericano de Desarrollo Integral de Aguas y Tierras, Project 213, Bogota, Colombia.

Descriptors: \*Water requirements, \*Arid lands, \*Precipitation (Atmospheric), \*Evapotranspiration, Moisture Evaporation, \*Evapotranspiration, Moisture availability Meteorological data, Consumptive use, Productivi availability, ty, Evaporation pans, Equations, Rainfall disposition, \*Climatic data.

Identifiers: Formulas, Moisture index.

Measured or computed evaporation and potential evapotranspiration, when combined with rainfall and effective precipitation, provided a valuable and useful index of moisture needs or deficiencies for forage or crop production in arid climates. Formulas were presented for computing evaporation from climatic data. Evaporation can be calculated from temperature data alone. Production was probably directly related to the degree to which the potential evapotranspiration or consumptive use require-ments were supplied by available moisture. Methods for improving moisture availability were listed and described. The ratio of effective precipitation to potential evapotranspiration Pe/Etp was proposed as a useful and valid index for the classification of climate. (Blecker-Ariz) W69-01470

#### 2E. Streamflow and Runoff

UNSTABLE MISCIBLE FLOW IN HETEROGENEOUS SYSTEMS, California University, Los Angeles. R. L. Perrine, and G. M. Gay. 2d Preprint, Symp, 58th Nat Meeting, Amer Inst Chem Eng, New York, NY, Feb 1966. 35 p, 8 fig, 2 tab. 6 ref connection. tab, 6 ref, append.

Descriptors: Numerical analysis, \*Heterogeneity, Porous media, Mathematical models, \*Computer models, Analytical techniques, Oil reservoirs, Dispersion, Approximation method, Flow characteristics, Three-dimensional. Identifiers: \*Flow instability, Miscible displacement, Linearized, Perturbation method.

Amethod is described of numerical computation for three-dimensional unstable miscible displacement behavior useful for heterogeneous systems, as well as under more ideal conditions. Flow equations are first linearized by a perturbation approach. The basic flow is separated and a solution for its behavior readily obtained. The remaining problem of deviations from the basic flow caused by nonideal conditions is subjected to numerical analysis. Results obtained from the method are presented. The following conclusions have been drawn: although the conditions assumed in test calculations have been severe, results obtained show the dispersing flow expected, and appear satisfacto-The method eliminated or reduced in importance problems of oscillating values near steep fronts and excessive computer smoothing. An unique advantage of the method is that one can see the source of variations from ideal behavior. One serious drawback results from the algebraic complexity of the perturbation approach, and the need for second order terms to be retained in calculations of interest. Fewer array points are available and more computer time is required than would be desired. These difficulties also are experienced with other approaches to the solution of threedimensional displacement problems. W69-01247

## HYDRAULIC MODEL OF RUNOFF FROM DEPRESSIONAL AREAS, Kentucky Univ., Lexington; Iowa State Univ.,

For primary bibliographic entry see Field 06A. For abstract, see . W69-01436

#### A DYNAMIC SIMULATION OF THE LOWER KANSAS RIVER DRAINAGE SYSTEM,

Federal Water Pollution Control Administration, Atlanta, Ga; University of Kansas, Lawrence.

Albert R. LeFeuvre, and Ernest C. Pogge. Amer Soc Civ Eng, Hydraul Div 16th Annu Spec Conf, Massachusetts Inst of Technol, Cambridge, Aug 1968. 41 p, 14 fig, 2 tab, 8 ref, disc, append.

Descriptors: \*Drainage basins, \*Watersheds, \*Simulation. Outflows. Hydrographs, Hydrometeorological \*Models. station, Discharges, Reservoirs, Rivers, Dynamics, Hydrology, Runoff, Streamflow, Streamflow forecasting, Computer programming.

Identifiers: \*Hydrologic models, \*Lower Kansas

Riv Valy (Kans), \*Kansas River Basin, \*Model studies, \*Mathematical models, Gaging stations.

A digital computer was used to simulate dynamic response of the Lower Kansas River Drainage System to unsteady hydrologic inputs. The model accounts for local inflow and upstream conditions. Boundary conditions for the model were the average daily flow hydrographs observed at 20 tributary stream gages. The hydrology of the river system was incorporated into a water quality model that simulated the distribution of conservative and nonconservative pollutants throughout the drainage system. Only the flow simulation is discussed. The model was verified by comparing machine-generated hydrographs for 5 mainstem stream gages with the corresponding observed hydrographs. Six time periods of approximately 40 days each are presented as verification of the model. (USBR) W69-01468

HYDRAULICS RESEARCH 1963 AND 1964. THE REPORTS OF THE HYDRAULICS RESEARCH BOARD WITH THE REPORTS OF THE DIRECTOR OF HYDRAULICS RESEARCH.

Department of Sci and Ind Res and the Ministry of Tech, 1964 and 1965, 84 pp and 96 pp.

Descriptors: \*Hydraulics, \*Runoff, \*Drainage, \*Pipes, \*Storm runoff, Estuaries, Model studies, Sewage effluents.

Identifiers: Surface permeability, \*Combined

Hydrological studies reported include: the factors affecting run-off in a permeable (chalk) catchment area and stream flow in an impermeable catchment: the effect of afforestation on the water balance of a catchment area; and lysimeter experiments on factors affecting evapotranspiration and drainage. Studies have continued on the attenuation of flood waves in partly-filled pipes, including tests on the mixing of an incoming surge of relatively clean storm sewage with the grossly polluted sewage in a combined sewage system. Studies on estuaries and tidal flow, carried out both in models and in the field, have included the problems of silting, dispersal and recirculation of heated effluents discharged from power stations, and dispersal of sewage effluents from outfalls, including flume tests on dispersion in steady turbulent flow. W69-01516

#### THE USE OF UNIT-SOURCE WATERSHED DATA FOR RUN-OFF PREDICTION. C. R. Amerman.

Wat Resour Res, Vol 1, pp 499-507, 1965.

Descriptors: \*Runoff forecasting, \*Demonstration watersheds, Subsurface runoff, Storms.

Run-off from 10 units forming a 76-acre complex watershed and from 2 units forming a 7.4-acre complex watershed in the North Appalachian experimental watershed near Coshocton, Ohio, was measured during storms during 1956. The partial run-off values were used to calculate a theoretical value for the run-off from each complex watershed, which was compared with the observed run-off. For the 76-acre watershed, the observed run-off was very much larger than the estimated run-off for small storms, but the two values approached as the storm size increased; in the case of the 7.4-acre

#### Group 2E—Streamflow and Runoff

watershed the estimated value was very much larger than the observed run-off for small storms and almost equal to it for large storms. In order to produce a better model for this type of calculation it was concluded that the question of sub-surface run-off, partial area flow, and the influence of runoff from the upper slopes on that from lower areas, should be considered. W69-01554

#### ASCE RESEARCH PROGRAM IN URBAN WATER RESOURCES.

Civ Eng. Vol 38, No 5, pp 70-71, May 1968.

Descriptors: Data collections, \*Design, \*Storm drainage, Instrumentation, \*Rainfall-runoff relationships, \*Water quality, Model studies, Drainage Identifiers: \*Urban drainage, \*Urban hydrology.

The ASCE Urban Hydrology Research Council has initiated a program to study and report on research and data needs for urban-water problems. The program currently consists of two major projects: Research and Analysis of National Basic Information Needs in Urban Hydrology and Systematic Study and Development of Long-Range Programs of Urban Water Resources Research. Under the first project an intensive study is being made of the types of data needed for improved design of stormdrainage facilities, including both quantity and quality of drainage-flow needs for data-collecting instrumentation; and for approval of types of networks necessary to collect adequate data. The ultimate objective is to facilitate transfer of data findings between metropolitan regions. The second project will attempt to provide guidelines for initiating and expanding a program of long-range studies on urban water problems. This includes: prefeasibility studies to determine the possible effectiveness, cost and time requirements for a comprehensive systems-engineering analysis of all aspects of urban water and for a general economic analysis of costs and pricing parameters of all aspects of urban water; a state-of-the-art study of mathematical models and related techniques for analyzing urban rainfall-runoff-quality processes; a study of requirements for the assessment of drainage damage and exploration of alternatives to direct storm-water runoff; and a study of political, economic, legal, and social problems related to urban water management.

#### SCALE MODEL OF URBAN RUNOFF FROM STORM RAINFALL,

For primary bibliographic entry see Field 02A. For abstract, see W69-01570

W69-01557

#### SOLUTION TO SURFACE RUNOFF PROBLEM, A. Y. Abdel-Razaq, W. Viessman, Jr., and J. W. Hernandez.

ASCE Proc, J Hydraulics Div, Vol 93, No HY6, Paper 5606, pp 335-52, Nov 1967.

Descriptors: \*Hydrographs, Runoff, Surface ru-

Surface runoff hydrographs are computed by relatively simple method consisting of reducing governing partial differential equations to ordinary differential equations at several nodal points along flow plane; these equations are then solved for time derivatives which are used in Taylor's series to approximate velocity and depth after increment in time; comparison with experimental data shows that runoff hydrographs were reproduced fairly accurately; numerical solution was shown to be stable and truncation errors negligible. W69-01572

#### **PROBLEMS** OF HYDROLOGICAL **FORECASTS**

Studii Hidrol, Inst Studii Cerc Hidroteh, Vol 13, 1965. 208 pp, 2 tab.

Descriptors: \*Runoff forecasting, \*Hydrographs, Discharge (Water). Identifiers: Roumania.

This publication contains the full text of 5 papers on the prediction of run-off and stream flow with special reference to conditions in Roumania. Aspects considered include the short-range forecasting of run-off by the trend method; forecasting of hydrographs of floods caused by precipitation, using the isochrones method; forecasting of mean discharges in the Danube over periods of 10 and 5 years, based on the water resources in the drainage area; short-range forecasting of discharges in the rivers Somes, Mures, Jiu, Olt, and Siret, based on water resources in the drainage area; and short-range forecasting of freezing and the breaking-up of ice on Roumanian W69-01573

RESEARCH REPORT OF THE CITY AND **GUILDS COLLEGE, 1961-64.** 

Imperial College of Science and Technology, (University of London).

Descriptors: \*Rainfall-runoff relationships, Computer programs, Model studies. Identifiers: \*Calculations.

This report includes sections on engineering hydrology (pp. 53-54) and public health engineering (p. 54). Studies on surface waters have included the flood response of a river to rainfall, propagation of a flood wave along a river, mechanism of run-off from an artificial catchment receiving 'rain' from a sprinkler, design of a network of hydrometric stations, and the use of modern techniques, including digital and analogue computers, to analyse hydrological data and investigate the relations between rainfall and run-off. A mathematical study was made of the flow of irrigation and rain water to horizontal tube drains, and the mathematics of diffusion were applied to the description of unsteady flow of ground water. Studies were also made on the relation between hydrology and water demand, particularly for irrigation, and on the management and planning of water resources, including the design and operation of storage reservoirs. In connexion with water and sewage treatment, model and prototype studies were made on the mixing characteristics of horizontal-flow sedimentation tanks, and work on mixed-bed filtration led to the development of an efficient graded filter with layers of polystyrene, anthracite, sand and garnet, the strata being graded so that they retain their relative positions during back-washing and so that the pore space decreases in the direction of flow, with consequent deeper penetration of removable material. W69-01574

#### A TECHNIQUE FOR ANALYSIS OF RUN-OFF HYDROGRAPHS.

D. L. Brakensiek.

J Hydrol, Vol 5, pp 21-32, 1967.

Descriptors: \*Hydrographs, \*Runoff, \*Computer

A single function, based on a transformation of the Pearson type III equation, was used to fit simple hydrographs, provision being made for the independent evaluation of discharges for the rising and falling limbs. Fitting principles, including those for computer use, are discussed and detailed, and a Fortran II source programme written for an IBM 1620 computer is listed. Using an on-line plotter, calculated hydrograph points were compared visually with observed curves. W69-01580

#### UNIT GRAPHS FOR NONUNIFORM RAINFALL DISTRIBUTION,

J. A. Buil.

ASCE-PROC, J Hydraulics Div, Vol 94, No HY1, paper 5762, pp 235-57, Jan 1968.

Descriptors: Drainage, \*Runoff, \*Hydrographs.

Correlation between Snyder's basin constants Ct and 640 Cp and basin physical characteristics of drainage area, total length, average slope length to center of area, and elongation is established using synthetic data: actual data are used to compensate for discrepancies introduced through initial use of synthetic data; effects of nonuniform rainfall distribution on basin runoff hydrographs is represented by unit graph, selected from three computed for each basin; computation formulas are presented to define each of three basin unit graphs; dimensionless unit graph is introduced for more accurate definition of rising and falling links of each unit graph. W69-01581

#### DISCHARGE FROM HEAVY RAINFALL.

Proc Inst Civ Engrs, Vol 25, pp 373-374, 1963.

Descriptors: \*Discharge (Water), \*Rainfall-runoff relationships.

In connexion with previous work on discharge from heavy rainfall, further studies have shown that no serious error was introduced by treating the flow as uniform (whereas the flow on the ideal catchment would be non-uniform) provided that the catchment was not very small. W69-01587

#### 2F. Groundwater

## STORAGE OF FRESH WATER IN UNDERGROUND RESERVOIRS CONTAINING SALINE WATER: PHASE I,

Kansas University, Lawrence Don W. Green, and Ronald L. Cox.

Kansas Water Resour Res Inst Rep, Kansas State Univ, Manhattan, Aug 1966. 96 p, 8 fig, 1 tab, 2 chart, 28 ref, 4 append. OWRR Project B-003-Kan.

Descriptors: Diffusivity, Groundwater recharge, Recharge wells, Saline water intrusion, Underground storage, Dispersion, Gravity studies, Computer models, Computer programs, Mathematical models, Saline water-freshwater interfaces, Groundwater movement.

A computer model has been developed for applica-tion to salt water-fresh water displacement processes in porous media. It is based on the numerical method of characteristics as presented by Garder, Peaceman, and Pozzi. The model is two-dimensional, allows for dispersion or mixing of the fluid-fluid interface, and accounts for fluid density differences. Porous-media properties are held constant. The details of the computer program including a listing are included in this report. Several calculations were made with the model approximating laboratory-scale displacement experiments and an actual field underground fresh water storage test. These calculations indicate the potential usefulness of the mathematical model. W69-01229

#### INDUCED ELECTRICAL POLARIZATION AND GROUNDWATER.

California University, Berkeley. Rene Bodmer.

OWRR Project B-002-CAL, Rep No MT 67-1, Col of Eng, Mar 1967. 101 p, 43 fig, 21 ref, 3 append.

\*Groundwater, Groundwater recharge, Resistivity, Clays, Geophysics, Electrical studies, Gravels, Exploration, \*Aquifers, Electrical properties, Electric currents, Polarization, Electrical impedance, Electric potential, Measuring instruments, Subsurface investigations.
Identifiers: \*Electrical prospecting, \*Induced

polarization method, Geophysical prospecting.

#### Groundwater—Group 2F

Conventional induced electrical polarization equipment was evaluated for investigating natural ground-water reservoirs in unconsolidated sediments. Clay horizons and other clay-bearing unconsolidated sediments are potential sources of induced polarization anomalies. Magnitudes of these anomalies are not expected to be large. However, if such anomalies may be detected above system noise, then the induced polarization method may be of value for in situ classification of unconsolidated sediments encountered in hydrological projects. One such project exists in Santa Clara County to determine whether or not induced polarization methods might be of value in potential recharge areas. Of 4 areas, only 2 yielded significant frequency effect anomalies and in each of these 2 the frequency effects were of order 3%. These anomalous frequency effects may be related to clayey gravels. The dipole-dipole array with spreads of 10 to 20 ft was typically used in the study. W69-01235

BAND DIFFUSION WITH VARIABLE PARAME-TERS ALONG FLOW,

Syracuse University, New York.

Wen-Hsiung Li.
J Eng Mech Div, Amer Soc Civ Eng, Proc Pap
4106, Vol 90, No EM5, pp 343-361, Oct 1964, 19 p, 8 fig, 14 ref, append.

Descriptors: \*Dispersion, Flow, Porous media, Groundwater, Wastes, \*Uniform flow, \*Diffusion, Porous materials, \*Engineering mechanics.

The diffusion equation with variable parameters along the flow can be solved when the diffused quantity is confined to a narrow band. Solutions are obtained for diffusion from a line source and a point source in nonuniform flows. The dispersion of a contaminant in nonuniform flows through porous media is studied. It is found that the dispersion across the streamlines can be estimated by using the solutions of diffusion from a line source and a point source in a uniform flow. (S. Mayer-FWPCA)
W69-01238

## DISTRIBUTION AND OCCURRENCE OF NEW MEXICO'S THERMAL WATERS--A STATISTICAL SUMMARY,

New Mexico Institute of Mining and Technology State Bureau of Mines and Mineral Resources,

Socorro. W. K. Summers.

Tech Pap, 20th Annu Meeting New Mexico Geol Soc, Roswell, May 1966. 9 p.

Descriptors: \*Thermal water, \*Thermal springs, Groundwater, \*Warm springs, Chemical analysis, Temperature, Aquifers, pH, Igneous rocks, Geothermal studies, \*New Mexico.

Of 67 areas in New Mexico reported to discharge ground water at temperatures of 90 deg or higher, 46 have been substantiated in the field, 10 do not exist at the locations reported or have lesser temperatures. Data for 46 areas that have been field checked show that (1) thermal waters occur in the western half of the State, primarily in Rio Grande and Gila-San Francisco drainage basins; (2) only 16 areas have been discovered by wells whereas 30 areas were marked by springs; (3) water issues from rocks ranging from Precambrian to Cenozoic age with Cenozoic rocks predominating; (4) waters are associated with igneous and sedimentary rocks in equal proportions; (5) water occurs primarily in areas of extensive volcanism and secondarily in fault zones; (6) water discharges from springs near streams but mostly at points well above river levels; (7) discharge may be from fractures directly from beneath a talus cover, or from alluvium or some combination (1 spring discharged from a tufa mound); (8) median pH is 7.4; mediam maximum temperature is about 105 deg F; median discharge of springs is 30.5 gpm and medium concentration for sodium, 146 ppm; magnesium, 4.55 ppm, potassium, 4.6 ppm, and lithium, 0.28 ppm. Most thermal waters have been used for some purpose, but only 18 are now being used.

#### GROUND WATER YIELDS IN THE RALEIGH

QUADRANGLE, North Carolina University, Chapel Hill. Charles W. Welby.

Water Resour Res Inst Rep 8, Univ N Car, May 1968. 61 p, 7 fig, 15 ref, 6 append. OWRR Project A-009-NC.

Descriptors: Bibliographies, Forecasting, \*Groundwater, Crystalline rocks, \*Water yield, Probability, North Carolina, Pump testing, \*Water wells.

Development of a method for comparing water yields from wells drilled in crystalline rocks as the basis of a probability study of well yields is reported. The method utilizes curves drawn from data collected during short-term pumping tests and is designed for use in crystalline rocks and in the absence of observation wells. All measurements are made on the pumped well. The method was developed to take into account the nature of ground water occurrence in the crystalline rocks of North Carolina piedmont, and in particular the Raleigh, North Carolina, area. The curves and the principles on which they are based permit prediction of probable yields from a given well at a variety of pumping rates. W69-01252

#### POTENTIAL GROUND-WATER HYDROLOGIC CHARACTERISTICS AS DETERMINED BY ELECTRIC RESISTIVITY CRITERIA,

Rhode Island University, Kingston.

John J. Fisher.

Water Resour Center, Univ RI, Final Rep, June 1967. 24 p, 7 fig, 10 ref. OWRR Project A-008-RI.

Descriptors: Geophysics, Resistivity, characteristics, Aquicludes, Water table, Sediments, Rhode Island, Physical properties, \*Groundwater, On-site data collections, Electrical conductance, \*Glacial drift, \*Aquifers.

Subsurface glacial deposits on Block Island, Rhode Island were studied in the field by induced electrical resistivity surveys to determine groundwater conditions. Vertical depth profiles (to 200 feet) were developed to show correlation between lithology, ground-water characteristics and conductance (reciprocal of resistivity). Depth to water table, zone of groundwater, and the presence of aquifers and aquicludes could be determined from the conductance data. The water table had high conductance values, ranging from .012-.015 mhos while aquifers in the zone of saturation were higher, ranging from .012-.024 mhos. In contrast, aquicludes were lower, ranging from .001-.007 mhos. The zone of soil moisture was intermediate in value, ranging from .009-.016 mhos. (Author) W69-01259

#### RESSLER V GERLACH )NEGLIGENT WELL CONTAMINATION(.

State of Pennsylvania, Harrisburg.

189 Pa Super 192, 149 A 2d 158-160 (1959).

Descriptors: Drill holes, \*Wells, \*Pennsylvania, Judicial decisions, \*Water pollution, Septic tanks, Water wells.

Identifiers: Negligent contamination.

Defendant sunk a 30 foot hole on his land, about 90 feet from a 34 foot well on Plaintiffs' neighboring land. The hole was sunk to facilitate drainage from septic tanks servicing defendant's apartment buildings. Thereafter water in plaintiffs' well became contaminated. Plaintiffs notified the defendant and he immediately filled the hole with dirt. The well water subsequently became usable for a period of one week, but later the well went dry. Evidence showed that plaintiffs' well was dug

through two layers of rock; the hole sunk by defendant was approximately to the same depth but did not go through the rock. There is no evidence to show that the defendant was negligent. Every man has a right to the natural use and enjoyment of his land and if while lawfully using his land, without negligence or malice, an unavoidable loss occurs to his neighbor, it is damnum absque injuria. (Molica-W69-01284

#### COMMONWEALTH DEP'T OF HIGHWAYS V SEBASTIAN )DIVERSION LOSS OF UNDERGROUND STREAM(. State of Kentucky, Frankfort.

345 S W 2d 46-47 (Ct App Ky 1961).

Descriptors: Judicial decisions, \*Kentucky, Diversion, Diversion losses, \*Underground streams, Alteration of flow, \*Springs, Watercourses (Legal), \*Surface - groundwater relationships, Grassed waterways, Channel flow, Percolating water, Preferences (Water rights), State governments, Condemnation, Administrative agencies, Natural flow doctrine

Plaintiffs sought damages against the Commonwealth of Kentucky, Department of Highways, for the drying up of two springs on their farm resulting from a diversion of the flow of water to the springs by construction of a highway. In Kentucky where underground waters flow in unknown and undefined channels the owner of land, when putting his land to legitimate use, is not liable to the owner of adjoining lands for injuries to wells or springs fed by the stream. In the case of underground currents flowing in known and defined channels the rights of the parties are the same as with respect to surface streams. The evidence for plaintiffs was that the course of an underground stream running from a neighbor's land across the highway right of way to the springs was identifiable and marked by a line of green grass which grew on the surface. The court held the evidence as to the existence of an underground stream flowing in a known and defined channel was properly submitted to the jury. (Smodish-Fla) W69-01307

#### HYDROLOGICAL STUDY OF THE LATTON GROUND-WATER SOURCE,

Swindon Corp Water Department, Swindon, Wilts, Great Britain

A. R. Burton.
J Inst Water Eng, Vol 22, No 4, pp 287-293, June 1968. 7 p, 2 fig.

Descriptors: Underground water storage, Percolation, Foreign projects, Water yield, Permeability, Water table, \*Aquifers, Specific yield, Thiem test, \*Groundwater flow, Groundwater recharge, Ground water, Hydrology, Drainage basins, Rain-

Identifiers: Groundwater management, Mathematical models, Water wells, Great Britain.

Investigations for developing a new source of ground water demonstrate the relationship between ground-water parameters and the reliability of a mathematical model for predicting groundwater levels. Past records show that rainfall, abstraction, and water level are interrelated. Estimates of ground-water yield are made by extrapolating past measurements. A mathematical model was developed, assuming that the piezometric surface within the radius of influence of a discharging well is dependent upon the: (1) mean flow rate from the discharging well, (2) sum of previous discharged quantities, and (3) sum of recharged quantities. Ground-water recharge is assumed to be solely from rain percolation. The mathematical model requires only elementary algebraic expressions for predicting ground-water levels. Aquifer properties may be estimated from coefficients used in the mathematical model. (USBR) W69-01410

#### Field 02-WATER CYCLE

#### Group 2F-Groundwater

A SINGLE-WELL METHOD FOR DETERMIN-ING THE DIRECTION AND VELOCITY OF FLOW OF UNDERGROUND WATERS-WATERS--RESULTS OF IN-THE-FIELD INVESTIGA-TIONS.

Institute of Nuclear Technology and Hydrogeological Enterprise, Cracow, Poland.

For primary bibliographic entry see Field 07B.

For abstract, see W69-01411

#### AQUIFER AND MODELS,

U. S. Geological Survey, Albuquerque, N. Mex. C. V. Theis.

Pap, Proc Ser No 4, Symp Amer Water Resour Assoc, San Francisco, Calif, pp 138-148, Nov 1967. 11 p, 6 fig, 9 ref.

Descriptors: \*Aquifers, \*Models, \*Ground water, Dispersion, Hydraulic conductivity Permeability, Wells, Observation wells, \*Groundwater flow, Anisotropy, Heterogeneity, Porous materials, Dis-

Identifiers: \*Groundwater movement, Transport phenomenon, \*Hydrologic models, Fluorescent tracers, Flow distribution.

A new conceptual model containing the known heterogeneity of the natural aquifer is needed to explain transport phenomena in ground water. The difficult problem of making the 2 sides of the continuity equation consistent is discussed. Various phenomena that occur when considering horizontal flow in an elastic confined aquifer are described. Changing values of parameters common to horizontal and vertical flow are stated. A chart shows the movement and concentration of a fluorescein tracer in a very coarse and permeable aquifer at the Hanford AEC. The hydraulic conductivity in aquifers ranging from about 2 to 4300 gal/day/sq ft in the order they were encountered by the drill is given. Another chart shows the same beds arranged in order of increasing conductivity with the corresponding logarithms of the conductivities. The range of permeability in water-bearing formations is shown. A laboratory model showing lateral dispersion of water in a small model is described. (USBR) W69-01443

#### LABORATORY EVALUATION OF SELECTED RADIOISOTOPES AS GROUND-WATER TRACERS.

Texas A and M Univ, College Station, Texas. A. Ray Jennings, and Melvin C. Schroeder. Water Resources Res, Vol 4, No 4, pp 829-838, Aug 1966. 10 p, 2 fig, 3 tab.

Descriptors: \*Groundwater movement, Base flow, Aquifers, \*Radioisotopes, \*Tracers, \*Tracking techniques, \*Laboratory tests, Chelation, Distribution patterns, Ion exchange, Adsorption, On-site data collections, Velocity, Porosity, Radioactivity, Ions

Identifiers: Elution, Exchange columns.

The determination of the rate and direction of ground-water flow with tracers provides knowledge that is useful in evaluating the water inventory of an aquifer. Antimony 121, cerium 141, chromium 51, indium 114, ruthenium 103, and strontium 85 in chelate form were tested in the laboratory. Distribution coefficients were determined for the chelated radioactive isotopes and for unchelated chromium 51 for chushed shale and limestone with calcium as the saturating ion by the batch-treatment procedure. These measurements could be used to predict the elution history of a tracer from an exchange column. Ghelated chromium 51 was found to be an adequate ground-water tracer. The average velocity of ground-water was equal to the sum of the tracer velocity plus the product of the tracer velocity, the distribution coefficient, and the bulk density of the aquifer divided by its effective porosity. (Affleck-Ariz) W69-01491

FIELD OBSERVATIONS COMPARED WITH DUPUIT-FORCHHEIMER THEORY MOUND HEIGHTS UNDER A RECHARGE BASIN,

Agricultural Research Service, Fresno, California. W. C. Bianchi, and E. E. Haskell, Jr.

Water Resources Res, Vol 5, No 1, pp 1049-1057, 1968. 9 p, 4 fig, 5 tab.

Descriptors: \*On-site tests, \*Recharge, Groundwater recharge, \*Groundwater basins, \*Dupuit-Forchheimer theory, \*Hydrographs, Theoretical analysis, Ponds, Mathematical models, Water spreading, Artificial recharge, Water table, Waste disposal, Aquifer characteristics, Vadose water, Boundaries (Surfaces). Aquifer characteristics, Equations.

Identifiers: Mounds, Groundwater mounds

Using Dupuit-Forchheimer assumptions, the rising and falling hydrograph of a groundwater mound beneath the center of a square or circular recharge basin has been theoretically described. The study reported in this paper tested for general agreement between these theories and actual field observations taken at the center of two experimental recharge ponds. The study also attempted to weigh considerations of scale, measurement, and geologic reality as to their significance in the reliability of an idealized mathematical model for the rise and fall of a ground-water mound. In water spreading for artificial recharge or waste disposal, prediction of the position of the water table during and after

spreading is of considerable operational importance. (Affleck-Ariz) W69-01492

INVESTIGATIONS INTO THE UNIFORMITY OF RELATION BETWEEN GROUND WATER AND RAINFALL OVER PROLONGED PERIODS AND THE POSSIBILITY OF PREDICTING GROUND WATER LEVELS WITH SPECIAL CONSIDERATION OF DRY PERIODS,

Dt Gewasserk Mitt, Vol 9, pp 73-85, 1965.

Descriptors: \*Groundwater, \*Rainfall-runoff relationships. Identifiers: Calculations.

A report, including tabulated and graphical results, is given of extensive studies carried out in 6 German towns at varying intervals over a period of 54 years on the distribution of rainfall and run-off, effective precipitation and temperature and stream flow. The effect of these characteristics on the response of the water table and their relation to climatic changes are discussed; it was found that the water table tends to respond to rainfall in a characteristic pattern, making it possible to predict shortterm changes in the ground-water level allowing for weather forecasts and dry weather periods. From these findings standard values for high medium low and very low rainfall are derived. W69-01588

#### 2G. Water in Soils

UNSATURATED FLOW IN DRAINAGE PROBLEMS.

Michigan State University, East Lansing R. J. Kunze.

OWRR Project A-003-MICH, Reprint, Amer Soc Civ Eng Proc, pp 40-45, Dec 1965. 3 p, 5 fig, 13

Descriptors: \*Drainage, \*Unsaturated flow, \*Groundwater flow, Soil moisture, Hydraulic conductivity, \*Flow, \*Subsurface flow, Diffusivity, \*Soil water movement. Identifiers: Diffusion coefficient.

Differences and similarities in conductivity and diffusivity data curves along with the functional role of these 2 flow parameters are discussed. Soil-water diffusivity appears to be the more complete flow parameter for investigating internal drainage of soils. Diffusivities obtained with 2 different methods over a sizable moisture range are in relatively good agreement, but data indicate that the diffusivity is not only moisture-dependent but is affected by time-dependent changes of the soil-water The observed time-dependent effect is directly related to the applied head. For computing the moisture status in a draining soil profile by means of the finite-difference form of the flow equation, a precise knowledge of the moisture history, the transmission coefficient-head and the moisture content-head relationships is necessary. W69-01237

#### AN INVESTIGATION INTO THE RELATION-SHIP BETWEEN METEOROLOGICAL VARIA-BLES AND STREAMFLOW.

Rutgers University, New Brunswick, N. J. College of Agriculture and Environmental Science. For primary bibliographic entry see Field 02A. For abstract, see. W69-01249

#### SPATIAL VARIATION IN THE MOISTURE CONTENT OF SANDY SOILS UNDER PINE STANDS.

All-Union Institute of Forestry and Mechanization of Forestry, USSR.

Soviet Soil Sci, Vol 10, pp 1337-1343, October 1967. 7 p, 2 fig, 3 tab.

Descriptors: Variability, \*Arid climates, \*Spatial distribution, \*Moisture content, \*Sands, Soil surfaces, Soil horizons, \*Pine trees, Soil moisture, Mcteoric water, Root zone, Rain water, Topsoil, Depth, Wetting

Identifiers: \*Sandy soils, Replications, Litter, Plots.

This article examined factors in spatial variation as well as influence of the latter on accuracy with which moisture content of sandy soils under pine stands could be determined. Variations in moisture content were determined at depths of 10-20, 40-50, and 140-150 cm. The amount of water retained by the litter was determined. There were different reasons for variations shown in the soil surface and deep horizons. Variation in moisture content of top soil horizons was due to uneven wetting, which was quite dependent on the thickness of the litter and the degree of moisture the day before it rained. In severely dried sandy soils, the reason for uneven wetting near the surface could have been the formation of a layer of saturated capillary-suspended moisture. In arid climates, such cases seemed to occur on open spaces under steppe vegetation and fallow where the top horizons would sometimes dry out below wilting moisture level. (Blecker-Ariz) W69-01484

#### IMPROVEMENT OF SOIL MOISTURE IN THE CONVERSION OF CHAPARRAL TO GRASS, California Univ, Riverside.

C. M. McKell, and J. R. Goodin. Proc 9th Int Grassland Congr, Vol 1, pp 573-575, 1966. 4 p, 6 fig.

Descriptors: \*Soil moisture, \*Chaparral, \*Grasses, Root zone, Vegetation effects, Moisture content, Rainfall, \*Arid lands, Brush control, Planting management, Water loss, Ranges, \* Water yield improvement, Wetting. Identifiers: Overstory, Plots, Seedlings.

Experimental plots were established to follow soil moisture changes in the root zone of vegetation cover in southern California. The first site was on a northeast slope supporting chamise and oak. The second site was on north, south and east facing slopes and supported a cover of chamise and oak At the first site, the 12 inch depth of soil showed the most erratic changes in moisture levels. Rapid wetting and drying cycles corresponded closely with occurring rainfall. A major factor in successful establishment of a new vegetation cover lies in moisture accumulation and conservation until the seedling is firmly enough established to draw upon

moisture reserves of a large soil volume. If native grasses are not present, removal of the overstory allows for an accumulation of soil moisture required for a successful program of range seeding. Correct timing with respect to rainfall and complete removal of the overstory are needed in arid areas in order to let native grasses make most efficient use of the moisture available to them. (Blecker-Ariz)

INFLUENCE OF EVAPORATION SUPPRES-SANTS ON WATER MOVEMENT IN SOILS,

Adelaide Univ, Glen Osmond, South Australia, Waite Agricultural Research Institute, Dept of Agricultural Biochemistry.
J. W. Kiine.

Aust J Soil Res, Vol 6, No 1, pp 67-73, July 1968. 7 p, 1 fig, 2 tab.

Descriptors: \*Alcohols, \*Retardants, \*Soil water movement, Soil amendments, \*Diffusivity, Capilla-\*Evaporation control, Monomolecular ry action, \*Evaporation control, Monomore and films, Infiltration, Wetting, Bulk density, Air-earth interfaces.

Identifiers: Fatty alcohols, Hydrophobic properties.

A study was conducted to investigate the influence of fatty alcohols on the rate of water movement through unsaturated soil, and to compare the effect of these fatty alcohols with the effect of other soil amendments. The fatty alcohols and dodecylamine had a stronger influence on soil-water diffusivity throughout the whole range of soil-water contents than did krilium, polyvinyl alcohol and Carbowax. The capillary flow of water to the soil surface was markedly reduced when treated with fatty alcohols. Dodecylamine reduced the rate of infiltration into the soil. Heats of wetting of the treated soil samples indicated that penetration rate and diffusivity near saturation were reduced in accordance with the hydrophobic character of the absorbed compound. (Affleck-Ariz) W69-01487

#### 2H. Lakes

WATER QUALITY AND PRIMARY PRODUC-TION OF SOUTH DAKOTA LAKES,

South Dakota State University, Brookings John G. Nickum, and Norman D. Schoenthal. Water Resour Res, Tech Res Proj, Completion Rep, S Dak State Univ, Dec 1967. 7 p, 1 ref. OWRR Project A-002-SDak.

Descriptors: \*Water quality, \*South Dakota, \*Lakes, \*Reservoirs, Limnology, Biology, Chemistry, Water analysis, Soil-water plant relationships, Aquatic plants.

Physical, chemical, and biological aspects of 45 lakes in S. Dak. were studied from July 1965 to July 1967. Maximum water temperature at the surface reached 28 deg C. Most lakes exhibited continuous circulation except when ice covered. Thermocline formation was observed in 6. Light transmission was influenced by turbidity, and varied greatly, within and among the lakes. Dissolved oxygen concentrations ranged from near saturation to less than the recommended minimum for fish life. All lakes were basic ranging from a pH of 7.1 to 11.3. Specific conductance of lakes occupying open basins was lowest in the unglaciated area west of the Missouri River (70-590 micromhos at 25 C) and highest in Mankato drift of the Wisconsin ice age (330-1260 micromhos at 25 C). Concentrations of major anions and cations tended to follow patterns which were associated with major physical divisions of the state or various drift types of the Wisconsin ice age. Trace elements were found in most lakes studied. Those lakes which developed dense summer blooms of phytoplankton were usually dominated by the blue-green algae Aphanizomenon or Microcystis. The maximum concentration of Chlorophyll as observed was 19.1 mg/1. Chlorophyll concentrations were generally igher in lakes east of the Missouri River. W69-01262

PRODUCTIVE CAPACITY OF NORTH AMER-ICAN LAKES AS RELATED TO THE QUANTI-TY AND TROPHIC LEVEL OF FISH, THE LAKE DIMENSIONS, AND THE WATER CHEMISTRY.

Dalhousie Univ, Halifax, Nova Scotia, Inst of Oceanography.

F. R. Hayes, and E. H. Anthony. Trans Amer Fish Soc, Vol 93, pp 33-57, 1964. 5 p, 1 fig, 5 tab, 14 ref.

Descriptors: \*Productivity, \*Yield equations, \*Secondary productivity, Eutrophication, Lake morphology, Comparative productivity, Regression analysis, Statistical models, Standing crop, Harvesting, Alkalinity, Fish types, Computers, Commercial fishing, Fishing, Census, Trophic level, Great

Identifiers: Hayes Productivity Index.

A Productivity Index (PI) for lakes derived from catch or biomass of fish, is defined by regression, log PI=0.236 + 0.000147a - 0.517b + 0.287c. where a = sq root of (100.000/area in sq km); b =log mean depth in m; c = log methyl orange alkalinity in ppm. Factors used in deriving regression include considerations of census method and trophic level of fish. T-test shows 3 slope constants in equation are highly significant. 10 alternative expressions for PI (using transformations of PI and functions of area, depth and alkalinity) resulted in coefficients of determination with range 0.301-0.665, as compared with 0.670 for best expression. Of this 67% in variability in PI for latter expression, 20% is due to areal function, 29% to depth, and 18% to alkalinity. Best equation yielded theoretical PI corresponding closely with observed PI in 41 lakes and lake groups. Ratio, observed PI/calculated PI, for variety of lakes or lake groups having various fisheries ranged from 0.43 for two Ontario lakes with trout angling to 3.73 for lake (Prince Edward Island) with pond fishery for small trout. Best value of ratio (0.91) was for L Ontario; 20 of 24 ratios reported fall within range 0.43-1.52. W69-01398

# STANDARD CORRELATIONS BETWEEN PELAGIC PHOTOSYNTHESIS AND LIGHT, Uppsala Univ., Sweden. Inst. of Limnology. Wilhelm Rodhe.

Mem Ist Ital Idrobiol, 18 Suppl, pp 367-381, 1965. 5 p, 8 fig, 1 tab, 9 ref.

Descriptors: \*Photosynthesis, \*Primary productivity, Light, Lakes, Oceans, Correlation analysis, Phytoplankton, Light penetration, Optical properties, Light intensity, Water properties, Mathematical models.

Identifiers: Transparency, Talling's model, Lake Tarfala, Lake Tornetrask, Sweden, Lapland, Lago Varese, Lake Erken, Bodensee, Zurichsee, Worthersee, Grand Ploner See, Ossiacher See, Lago Maggiore, Le Leman.

Response of pelagic photosynthesis to vertical attenuation of light follows a general pattern, common to various types of lakes as well as to the sea. Based on Talling's model for the photosynthetic integral, and attempt is made to define quantitative standard correlations. These facilitate the assessment and interpretation of photic and non-photic effects upon primary production of phytoplankton. Data are presented for 12 lakes with Secchi disk transparencies of 1.7 to 13.7 m and with integral assimilation values (C) between 45 and 1600 carbon/sq m/day. The best relationship shows C to be the product of a parameter, optical depth at which light saturation of photosynthesis occurs, and maximal assimilation (B) in milligrams of carbon/cu m/day. Ratio of observed C to C calculated from above relationship gives a mean of unity, deviations from which do not exceed 6.7%. With a slight modification, relationship can also be used to approximate estimates of total photosynthesis in cases where only the optical properties of water and the maximal photosynthetic rate are known. This less exact relationship is shown to be C = (B)(A-prime), where A-prime is metric depth at which the most penetrating component of light is attenuated to 10%

W69-01458

#### 2I. Water in Plants

WATER LOSS THROUGH INTERCEPTION BY MIXED-OAK FORESTS IN RHODE ISLAND,

Rhode Island University, Kingston.

James H. Brown, Jr.

Water Resour Center, Univ RI, Completion Rep, June 1967, 4 p. OWRR Project A-001-RI.

Descriptors: \*Interception, \*Streamflow, \*Canopy, Water loss, \*Oak trees, \*Throughfall, Deciduous forests, Rhode Island, Leaves.

Mixed-oak canopy was found to intercept 10.1% of rainfall received during a leafless period from February 1 to May 22, 1966, and 13.1% during the subsequent leaf period. Of the rainfall reaching the ground under the forest stands, throughfall amounted to 85.1% of rainfall received in the open during the leafless period, while stemflow amounted to 4.8%. In contrast, when leaves were present percentages were 83.3 and 3.6 for throughfall and stemflow, respectively. It was found that net precipitation during the leaf period was not influenced by size class of mixed-oak forest, at least within the range of size classes studied which included oak stands averaging 30, 40, and 50 feet in height. The same could be said for the leafless period except that stemflow yields differed under the three size classes. Large differences in stemflow were observed between different oak species. Differences were attributed to bark characteristics and branching habits. (Author) W69-01260

STRUCTURE OF FOREST VEGETATION BOR-DERING THE SAYLORVILLE IMPOUND-MENT,

Iowa State University, Ames. Roger Q. Landers, and Dana R. Sanders. Iowa State Univ Sci Tech, Proj Completion Rep, Aug 1967. 27 p, 9 fig, 10 tab, 2 ref. OWRR Project

Descriptors: \*Vegetation, Forests, Watershed management, \*Slopes, Pre-impoundment, Surveys, Oak trees, Maple trees, Forest management. Identifiers: Des Moines River (Iowa), \*Saylorville Reservoir (Iowa)

Sites chosen in the Saylorville Reservoir area were studied from standpoints of classification, composition of slope forests, and preimpound-watershed description. Important canopy species in the majority of stands include elms, ironwood, and ash. On drier sites white oak and shagbark hickory are dominants, with important understory species of Ribes spp., Parthenocissus quinquefolia, and Xanthoxylum americanum. Red oak, black maple, and basswood are more abundant on mesic sites and characteristic understory species include thalictroides, **Parthenocissus** quinquefolia, Hepatica acutiloba, Carex alursina, and Asarum canadense. The above 2 categories describe the majority of sites. Any number of tree species may be dominant in the canopy from site to site, and understory dominants also show this variation. In considering management of these slope forests, our hypothesis is that the great majority of slope forest species will not withstand periods of flooding. Changes in structure and composition of vegetation will occur. This results in a predominance of opportunistic species capable of withstanding the stresses of flooding but undesirable for recreational use or watershed protection. W69-01264

STRUCTURAL CHARACTERISTICS OF BENTHIC ALGAL COMMUNITIES LABORATORY STREAMS,

Oregon State Univ, Corvallis C. David McIntire. Ecol, Vol 49, No 3, pp 520-537, Late spring 1968. 18 p, 5 fig, 7 tab, 31 ref.

#### Group 21-Water in Plants

Descriptors: \*Laboratory tests, \*Benthic flora, \*Aquatic algae, \*Biological communities, Stream-Adjusted argae, Biological committees, Steam-flow, Currents (Water), Diatoms, Cyanophyta, Light intensity, Productivity.

Identifiers: \*Autecology, Species diversity, Com-

munity structure.

Effects of light intensity and current velocity on species composition and ecology of benthic algal communities were examined in laboratory streams. Of 15 diatom taxa studied, only Melosira varians, Navicula radiosa and Meridion circulare were more abundant in streams receiving 700 ft-candles of light than in those at 150 ft-candles. Achnanthes exigua, A minutissima, Meridion circulare, Rhoicosphenia curvata and Navicula radiosa were indifferent to current velocity, which had a positive effect on quantity of Navicula cryptocephala, N N seminulum, Nitzschia minima. linearis. Synedra Achnanthes lanceolata, Gomphonema parvulum, G angustatum, Cocconeis placentula and lanceolate Nitzschia. Melosira varians was more abundant in standing water. Of six non-diatom taxa, Anabaena variabilis and Tribonema minor were more abundant in streams at higher light intensity and Phormidium retzii was more abundant in moving water than in standing. At a particular season, light intensity and current velocity conditions in laboratory streams allow establishment of an algal community with characteristic species composition, biomass, pigment concentration and increment of export. To understand productivity in such communities one needs knowledge of the autecologies of community constituents and of mechanisms regulating floristic diversity and species composition. W69-01397

SEEDING ANNUALS AND PERENNIALS IN NATURAL DESERT RANGE.

Hebrew University of Jerusalem; Volcani Institute of Agricultural Research, Newe Ya'ar Experiment

For primary bibliographic entry see Field 03F. For abstract, see . W69-01475

THE INFLUENCE OF GRAZING- AND CUTTING-TREATMENTS ON WATER USE UNDER PERMANENT PASTURES IN GER-

MANY, Bonn Univ, Institut fur Pflanzenbau, Germany. For primary bibliographic entry see Field 03F. For abstract, see . W69-01478

PHOTOSYNTHESIS AND RESPIRATION OF FOUR PASTURE GRASSES AS AFFECTED BY MOISTURE CONDITIONS AND SALINITY, Florida Univ, Agricultural Experiment Station For primary bibliographic entry see Field 03C. For abstract, see W69-01479

SOIL MOISTURE AVAILABILITY TO SOME MESIC AND SEMI-XERIC SPECIES.

Purdue Univ, Lafayette, Indiana; Universidade Rural do Estado de Minas Gerais, Vicosa, Minas Gerais, Brasil.

For primary bibliographic entry see Field 03B. For abstract, see . W69-01480

MOISTURE USE OF PASTURE PLANTS IN A DESERT ENVIRONMENT,

Volcani Institute of Agricultural Research, Rehovot, Israel; Hebrew University of Jerusalem. N. H. Tadmor, O. P. Cohen, and L. Shanan. Proc 10th Int Grassland Congr, pp 897-906, 1967. 10 p, 3 fig, 2 tab, 24 ref.

Descriptors: \*Water requirements, Water utilization, Grazing, Crop response, \*Vegetation establishment, Deserts, \*Drought resistance, Arid lands, Evapotranspiration, Plants, Ranges, Surface runoff, Slopes, \*Water spreading, Soil-water-plant relationships, Pasture management, \*Soil moisture, Carrying capacity.

Identifiers: Israel, Perennials, Annuals, Negev

The paper summarized data on water requirements and drought resistance of seven range plants at Advat Desert Research Center in the Central Negev desert of Israel. It was shown that even in a 100 mm rainfall desert some of the most useful perennial and annual pasture plants may be established and maintained by exploiting surface runoff from desert slopes. Even under such extreme drought conditions some of the plants investigated gave high yields and were efficient water users, giving a performance comparable to that of irrigated forage crops. Water-spreading in the bottomlands seemed to be a feasible method for improving the overall desert range with regards to carrying capacity, season of use and nutritive potential. Differences in water use between plants were related to length of growing season and rooting depth. (Blecker-Ariz) W69-01483

#### 2.I. Erosion and Sedimentation

THE EFFECT OF A PERMEABLE BED ON SEDIMENT MOTION,

Georgia Institute of Technology, Atlanta. C. S. Martin.

Water Resour Center, June 1966. 67 p, 38 fig, 13 ref. OWRR Project B-004-Ga.

Descriptors: \*Beds (Stream), \*Sediment transport, \*Porous media, \*Seepage, \*Earth-water interfaces, Hydraulic gradient, Permeability, Slope stability, Bottom sediments, Hydrodynamics, Beds under water, Sediment-water interfaces, Stream erosion, Degradation (Stream).

The seepage force on uniform, cohesionless bed particles (sand) that comprise the top layer of a stream bed was determined experimentally. Slope stability tests were conducted by directing water normal to the plane of the bed. Results of tests for which the water flowed vertically upward into a horizontal bed were the most conclusive. The seepage force on the grains forming the interface was found to be about one-half the seepage force on grains well within the bed. Tests were made on the erosion rate following incipient failure with the bed in a horizontal position and the flow directed vertically upward. The rate of erosion was correlated with the rate of seepage (hydraulic gradient). A hydraulic gradient corresponding to an extrapolated rate of erosion of zero was minus 3.2. The corresponding seepage force on grains at the interface is about one-third the seepage force well within the bed. The seepage force on uniform, cohesionless bed particles at the sand-water interface is correlated to be about one-third to one-half the seepage force on particles well within the bed. W69-01266

ANALYSIS OF OVERLAND FLOW ON SHORT EROSION PLOTS,

Purdue Univ, Lafayette, Indiana. For primary bibliographic entry see Field 02A. For abstract, see W69-01408

#### 2K. Chemical Processes

INTERACTION BETWEEN ALUMINUM AND PHOSPHATE IN AQUEOUS SOLUTION, Rutgers-the State Univ, New Brunswick, NJ, Dept of Soils and Crops. Pa Ho Hsu.

Related to OWRR Project B-008-PA: 'Removal of Phosphate from Water by Aluminum and Iron', October, 1968. Advances in Chemistry Series, No. 73, pp. 115-127, 1968.

Descriptors: Hydrolysis of Al3+/hydroxy-aluminum polymers, Soluble aluminum phosphate complexes, Aluminum phosphate precipitates, Phosphate removal.

This report deals with the reaction mechanism between aluminum and phosphate. It was found that by adding NaOH to AlCl3 solutions the resultant solutions contained Al3+ ions and also positively charged hydroxy-aluminum polymers. The polymers and Al3+ ions yielded different reaction products with phosphate. Hydroxy-aluminum polymers were completely and immediately precipitated by phosphate at their isoelectric points. This precipitation is interpreted to be a simple 'neutralization' of the net positive charge of polymers by the phosphate anion. Al3+ formed soluble complexes with phosphate, no precipitate being observed up to a H2PO4/Al molar ratio of eight. In solutions which contain both polymers and Al3+, each reacted with phosphate separately, and the reation product will depend greatly on the nature of the aluminum originally present in the solution. (Author) W69-01407

#### 2L. Estuaries

PARTITIONING OF THE ESTUARINE EN-VIRONMENT OF TWO SPECIES OF CANCER, Rhode Island University, Graduate School of

Oceanography. For primary bibliographic entry see Field 06G.

For abstract, see . W69-01241

#### **CURRENT STUDIES IN PAMLICO RIVER AND** ESTUARY OF NORTH CAROLINA

North Carolina University, Chapel Hill. Donald B. Horton, Edward J. Kueuzler, and William J. Woods.

Water Resour Res Inst, Univ N Car, July 1967. 21 p, 2 fig, 4 tab, 7 ref. OWRR Project A-014-NC.

Descriptors: \*Dye releases, Tracers, \*Estuaries, \*Model studies, Tidal effects, River flow, Salinity, Stratified flow, Inflow, \*Path of pollutants, Dispersion, Diffusion, Currents (Water), Diffusivity. Identifiers: \*Rhodamine B, \*Flushing time.

Rhodamine B dye was released in the Pamlico River estuary during the summer of 1967. The movement and concentration of the dye was followed wow through cuvettes. The average net movement of the dye patch was 915 m per day downstream. This movement was compared to predicted water movements derived from a tidal prism model of estuarine flushing. Under low fresh water inflow conditions as existed at the time of dye insertion, the predicted average transport was only 213 m per day. The discrepancy was due to a combination of factors inherent in the application of the theoretical model: (1) Possible substantial errors in the estimation of fresh water inflow; (2) No independent estimation of wind transport; (3) Vertical variation in fresh water outflow. The theoretical model was used to estimate flushing under average waterflow conditions. Under these conditions corrections for vertical stratification were possible and substantial errors in the estimation for fresh water inflow were obviated. Flushing time was estimated to be 65 days for the entire length of the estuary. Although there was a discrepancy between observed and calculated salinities, diffusive salt flux could account for the differences. Independent water current determinations did fit the model W69-01251

#### Water Yield Improvement—Group 3B

ESTUARY COMPREHENSIVE DELWARE STUDY PRELIMINARY FINDINGS. REPORT AND

Federal Water Pollution Control Admin., Phila.,

July 1966, 113 pp, figs.

Descriptors: \*Estuaries, Water quality, \*Storm ru-\*Overflow, \*Water pollution, \*Sampling, \*Biochemical oxygen demand Identifiers: \*Combined sewers

The Delaware river estuary - particularly the segment between Trenton and the Pennsylvania-Delaware state line below Wilmington - was studied from the points of view of municipal and industrial waste discharges, water quality and its improvement by five specific alternative objective sets, water use, costs and benefits of projected improvements, and guidelines for implementation. Stormwater overflow discharges (discussed on pp. 24, 61, 92) are considered esthetically objectionable, although in comparison with other waste input it does not constitute a large source of oxygen-demanding pollution of the estuary. A continuation of the reported stormwater sampling program is urged, and a demonstration project to counteract undesirable effects of combined sewer overflow is recommended. W69-01522

#### 03. WATER SUPPLY **AUGMENTATION** AND CONSERVATION

#### 3B. Water Yield Improvement

GROUND WATER YIELDS IN THE RALEIGH

QUADRANGLE, North, Carolina University, Chapel Hill. For primary bibliographic entry see Field 02F. For abstract, see . W69-01252

LEGAL ASPECTS OF WEATHER MODIFICATION—SNOW PACK AUGMENTATION IN WYOMING,

Wyoming University, Laramie.

John M. Pierce.

Land Water Law Rev, Vol II, No 2, pp 273-319, 1967. 47 p, 167 ref. OWRR Project A-999-Wyo.

Descriptors: \*Weather modification, \*Legal aspects, Snowpacks, Water yield improvement, Snowmelt, Flow augmentation, \*Developed waters, Water allocation (Policy), Water resources development, Cloud seeding, Water supply.

The article focuses on the legal problems of ownership, control and liability as they are related to snowpack augmentation. Snowpack augmentation is but a small segment of weather modification, other segments--fog, hail, rain--are briefly mentioned. A discussion and analysis of the very few cases and statutory enactments is included, as is a discussion of the various legal theories on which the ownership of clouds and moisture can be predicated. The allocation of any runoff which results from snowpack augmentation must be considered in light of documents presently controlling the allocation of water--as an example the Colorado River Compact is studied. The increased runoff resulting from snowpack augmentation may be viewed as imported or developed water, and cases dealing with both imported and developed waters are studied. Other aspects--the right to store increased runoff in existing facilities, the importer's right to use the natural channel and the liability of the weather modifier are also discussed. (Wing-Wyoming) W69-01263

AN ACT...TO CONSERVE AND PROTECT WATER RESOURCES OF THE STATE: TO PROVIDE FOR CLASSIFYING OF ALL WATERWORKS, WASTEWATER WORKS AND INDUSTRIAL WASTEWATER WORKS... Maryland Laws ch 430 (1967).

Descriptors: \*Maryland, Legislation, Administrative agencies, Classification, Legal aspects, \*Regudustrial wastes.

\*Certification, lations, Waterworks, Waste water treatment, In-

\*Superintendants,

Section 406A was added to Article 43 of the Annotated Code of Maryland (1965 Replacement Volume), title 'Health', subtitle 'Water, Ice and Sewerage.' The Act provided for the classification of all water works, wastewater works and industrial wastewater works. It also required the examination and certification of all superintendants, the people in charge of the operation of the various waterworks. A governor appointed Board of Certifica-tion was established to implement the requirements. The State Department of Health and the State Department of Water Resources was directed to provide training to prepare superintendants for certification. A fine of \$25 a day was established for any violation of the Act. (Sisserson-Fla)

SOIL MOISTURE AND TEMPERATURE CHANGES FOLLOWING SAGEBRUSH CON-TROL,

Wyoming Univ., Laramie.

Herbert G. Fisser.

J Range Manage, Vol 21, No 5, pp 283-287, September 1968. 5 p, 7 fig.

Descriptors: \*Temperature, \*Soil moisture, \*Sagebrush, \*Productivity, \*Grasslands, Arid climates, Water loss, Seimarid climates, Seasonal, Soil temperature, Shrubs, Moisture availability, Brush control, Wyoming, Vegetation effects, Crop response, Grazing, Rainfall disposition, Soil-water-plant relationships. plant relationships. Identifiers: Herbage, \*Mesic.

A study was conducted in western Wyoming to evaluate soil moisture, soil temperature and herbage production changes following chemical control and non-grazing treatments of big sagebrush. Two sites, one a mesic grassland and the other an arid shrub type were studied. Soil moisture recharge during the spring period at the mesic site was much greater under the non-use treatment than in the grazed area. Soil moisture withdrawal was similar at both the arid and mesic sites. Variation of seasonal moisture levels combined for all depths and years showed a much greater variation at the mesic site than at the arid site. At the mesic site, grasses utilized almost all available moisture in the upper two feet of the soil. That which was not utilized moved downward to accumulate in the 36-60

TOPOGRAPHIC MODIFICATION OF LAND FOR MOISTURE ENTRAPMENT,

inch zone from which sagebrush draws its major

Nebraska Univ, Lincoln.

water supply. (Blecker-Ariz) W69-01469

H. D. Wittmuss.

Trans Amer Soc Agr Eng, Vol 11, No 3, pp 384, May-June 1968. 1 p.

Descriptors: \*Topography, Moisture content, \*Runoff, Semiarid climates, \*Land forming, Terracing, Land management, Great Plains, Soil moisture, Soil management.

Identifiers: Bench terraces.

Conservation bench terraces provide a more effective means of moisture conservation than the practice of summer fallow in semi-arid regions of the United States. Graded terraces allow water to run off when heavy rainfall occurs, whereas level terraces with closed ends concentrate runoff water in

the terrace channel where deep percolation occurs. Runoff losses from graded terraces averaged 1.2 inches per year during the 11-year study period. Results indicated that substantial yield increases could be expected by leveling the terrace channel which would alleviate deep water ponding in the terrace channel and increase efficiency of water use by crops. Level or graded terraces could be employed in arid climates to utilize soil and water resources more effectively. (Blecker-Ariz)

PROBLEMS OF LAND MANAGEMENT IN THE VARIOUS PHREATOPHYTE ZONES,

Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado. Jerome S. Horton.

66-3 Meeting of the Pacific Southwest Interagency Committee, Albuquerque, New Mexico, August

Descriptors: Arid climates, \*Land management, \*Phreatophytes, \*Tamarisk, Transpiration, \*Water yield improvement, Ecology, \*Brush control, Intermittent streams, Perennial streams, Vegetation effects, Water temperature, Flood plains, Transpiration, Playas, Riparian plants. Identifiers: Shade

Land occupied by phreatophytes presents a problem not solely in plant eradication, but also in land management in order to bring about proper use of all resources inherent in the West. Tamarisk or saltcedar, which is a very common phreatophyte, is discussed with respect to origin, ecology and position as an aggressive phreatophyte in the West. Cutting of vegetation along perennial and intermittent streams in the Southwest will have a compounding effect since the removal of shade will increase water temperature, which will create greater evaporation losses that may not be compensated in full by reduced transpiration from the smaller number of trees. (Blecker-Ariz) W69-01473

THE IMPROVEMENT OF DESERT RANGES IN UZBEKISTAN,

All-Union Research Institute of Darakul Sheep Husbandry, Samarkand, USSR. Sh Shamsoutdinov.

Proc 10th Int Grassland Congr, pp 960-962, 1967.

Descriptors: \*Sagebrush, Arid lands, Soil moisture, \*Shelterbelts, Deserts, \*Ranges, \*Vegetation establishment, Forages, Winter, Productivity. Identifiers: Uzbekistan, Saksaul, Fodder, Ephemer.

The planting of black saksaul shelter belts in Sagebrush-ephemer deserts together with the establishment of fall-winter ranges in foot-hill deserts and cultivation of fodder crops, without irrigation, to provide feed on ranges in winter are ways that are used to conserve moisture on desert ranges. Black saksaul shelter belts act as windbreaks and snow accumulators. The nearby humidity level is increased and as a result a milder and more stable microclimate is created which promotes normal growth and development of range plants. (Blecker-Ariz) W69-01476

SOIL MOISTURE AVAILABILITY TO SOME MESIC AND SEMI-XERIC SPECIES, Purdue Univ, Lafayette, Indiana; Universidade Rural do Estado de Minas Gerais, Vicosa, Minas Gerais Brasil D. J. Sykes.

Proc 9th Int Grassland Congr, Vol 1, pp 399-402, 1966. 4 p, 3 fig, 1 tab.

Descriptors: Arid climates, \*Xerophytes, \*Soil moisture, \*Moisture tension, Capillary conductivity, Soil-water-plant relationships, \*Moisture availability, \*Wilting point, Field capacity, Osmotic pressure, Turgidity, Growth chambers, Absorption, Environmental effects.

#### Field 03-WATER SUPPLY AUGMENTATION AND CONSERVATION

#### Group 3B-Water Yield Improvement

Identifiers: Mesic, Turgor pressure, Crawl.

Soil moisture tensions at the permanent wilting percentage were determined with five plant species on soils with high and low moisture conductivity. Results ranged from 39 atmospheres with Agropyron intermedium to seven atmospheres with Helianthus annuus and showed highly significant differences between soils, species and environmental conditioning. The major limiting factor determining the permanent wilting of plants was the rate of moisture contrast to the 15 atmosphere concept. Xeric species or plants hardened by environmental conditioning may withstand high soil moisture tensions while soil moisture moves slowly to their roots. Such plants may have low permanent wilting percentages and may take up and utilize water held at tension considerably above 15 atmospheres. This condition can occur in many arid parts of the world. (Blecker-Ariz) W69-01480

#### ECONOMIC FACTORS IN THE IMPROVE-MENT OF ARID AND SEMI-ARID GRASS-LANDS,

Forest Service, Division of Range Management. L. Rader.

Proc 9th Int Grassland Congr, Vol 2, pp 1593-1597, 1966. 5 p, 1 tab.

Descriptors: \*Arid climates, \*Economic feasibility, \*Grasslands, Range management, \*Sagebrush, Droughts, \*Semiarid climates, Productivity, Costbenefit analysis, Brush control, Carrying capacity, Livestock, Grazing, Vegetation regrowth, Pasture management.

Range improvement and management practices can be used to increase productivity of arid and semi-arid grazing lands. An analysis of factors influencing costs and returns from range improvement, using removal of sagebrush as an example, suggests that actual costs of improvement are related to the method of improvement, site conditions and size of the area improved. Sagebrush grows in areas where precipitation is low and where there are large fluctuations in annual rainfall with frequent and often prolonged droughts. With removal of sagebrush, more water becomes available for the growth of grass. This in turn will in increase range carrying capacity and result in in-creased livestock production. Examples of three possible situations and two levels of improvement costs are given. They illustrate that improvement of sagebrush ranges may be profitable on better sites and that relatively small investments may be justified on sites, where potential capacity is low. (BleckeF-Ariz) W69-01482

#### PHREATOPHYTES-WATER USE AND POTENTIAL WATER SAVINGS,

Agricultural Research Service, Boise, Idaho. Dean C. Muckel.

J Irrig and Drain Div ASCE, Vol 92, No IR 4, Proc Paper 5033, pp 27-34, Dec 1966. 8 p, 2 fig, 2 tab.

Descriptors: \*Phreatophytes, \*Water utilization, \*Water conservation, \*Evapotranspiration, Arid climates, Semiarid climates, \*Brush control, Tamarisk, Water table, Plant populations. Identifiers: Greasewood

Salvage of water consumed by phreatophytes of low economical value had long been considered, and increasing emphasis is being placed on this source of water in the arid and semi-arid west. Evaluation of potential savings in water use requires that water use be estimated under present and modified conditions. The problems of measuring evapotranspiration by phreatophytes were examined. Salvage of water now being used is difficult because the plants are persistent and difficult to eradicate. Three methods of salvage were listed. The eradication of both salt cedar and greasewood were discussed. (Affleck-Ariz)

## 3C. Use of Water of Impaired Ouality

PHOTOSYNTHESIS AND RESPIRATION OF FOUR PASTURE GRASSES AS AFFECTED BY MOISTURE CONDITIONS AND SALINITY,

Florida Univ, Agricultural Experiment Station. Vincent N. Schroder.

Proc 10th Int Grassland Congr, pp 181-184, 1967. 4 p, 4 tab.

Descriptors: \*Pastures, \*Grasses, \*Soil moisture, Salinity, Photosynthesis, Respiration, \*Plant growth, \*Salt tolerance, Flooding, Irrigation effects, Water injury, Soil-water-plant relationships.

A study was designed to determine tolerance of several widely grown pasture grasses to salinity and flooding and to study the effect on rates of photosynthesis, respiration, and overall growth. The four warm-season grasses were: Pangola grass, Pensacola Bahia grass, Coastal Bermuda grass and St. Augustine grass. All four species were tolerant to levels of sodium chloride as high as 4500 ppm in the irrigation water. Continuous flooding for a period of 36 days was not harmful. Bermuda and St Augustine grass were the most tolerant of high levels of salt. Chemical data suggested that Bermuda grass does not absorb sodium as readily as the other grasses and that St. Augustine grass absorbed and could tolerate higher levels within the plant. Since salinity is usually considered to affect growth in a large measure by imposing a water stress on plants, data in the study could be used in arid regions where water stress is an important aspect of plant growth. (Blecker-Ariz) W69-01479

#### SPRINKLER IRRIGATION WITH HIGH SALT-CONTENT WATER,

Arizona Univ, Tucson. C. D. Busch, and F. Turner, Jr. Trans ASCE, Vol 10, No 4, pp 494-496, 1967. 3 p, 2 fig, 5 tab.

Descriptors: Irrigation systems, Irrigation effects, \*Saline water, \*Sprinkler irrigation, \*Cotton, Diurnal, Crop response, Water quality, Water loss, Water requirements, Toxicity, Leaves, Evaporation, Furrow irrigation, Surface irrigation.

A study was conducted in Safford, Arizona, to determine the effects of saline water sprinkling on the yield of cotton. Besides comparing day versus night sprinkling, the study included comparisons of flat and furrowed soil surface on both long staple (S-2) and short staple (1517D) varieties of cotton. The two-year study of sprinkling cotton with saline (3,160 ppm) water showed that the higher daytime evaporation losses from sprinkling markedly affect both the sodium content in plant leaves and the crop yield. The normal diurnal fluctuations plus problems of sprinkler adjustment suggested that night sprinkling presented a reasonable procedure for sprinkler irrigation with water classified as poor in quality. (Affleck-Ariz) W69-01489

## 3D. Conservation in Domestic and Municipal Use

PERIMETER DRAINAGE TO PROTECT URBAN LANDS,

R. T. Chuck.

ASCE Proc, J Urban Planning Devel Div, Vol 93, No UP1, Paper 5055 pp 1-12, Jan 1967.

Descriptors: \*Drainage systems, \*Planning. Identifiers: \*Urban drainage, Hawaii.

Perimeter drainage is challenging approach for providing drainage protection to urban lands; essential in its concept is consideration of alternative uses of existing natural water courses; by using man-made waterways to supplement, alter, or entirely eliminate existing natural drainage pattern, perimeter drainage affords means of providing adequate protection to urban lands, while preserving and enhancing their economic and aesthetic values; successful experience in Hawaii suggests that perimeter drainage has considerable merit in urban planning and development and should be given more serious attention in well-planned urban lands.

W69-01565

#### 3E. Conservation in Industry

WATER CONSERVATION IN FOOD PROCESSING PLANTS, Maine University, Orono.

Maine University, Orono.
For primary bibliographic entry see Field 05D.
For abstract, see .
W69-01265

#### 3F. Conservation in Agriculture

OPTIMAL TIMING OF IRRIGATION,

California Univ., Riverside; Nevada Univ., Reno. For primary bibliographic entry see Field 06A. For abstract, see . W69-01214

AN ACT AMENDING THE ACT OF MAY 15, 1945 )PL 547(, ENTITLED, AS AMENDED, 'AN ACT RELATING TO SOIL CONSERVATION AND SOIL EROSION...'.

State of Pennsylvania, Harrisburg.

Laws of Penn 1967, Act 382.

Descriptors: \*Pennsylvania, Legislation, \*Administrative agencies, State governments, Soil conservation, Water conservation, Adoption of practices, Erosion control, Project purposes, Local government, Project planning, Erosion control, \*Standards, Administration, Social aspects, Management, Soil management, Water management.

A state soil and water conservation commission is established, consisting of four farmers and two urban members in addition to state administrative officers and the dean of the state college of agriculture. Commission duties include coordination of soil and water conservation programs among the various districts herein described, extension of government aid to land and water management programs and to private lands, and creation of soil and water conservation districts when the various county commissioners and rural landowners favor such action. Membership in the board of the county water and soil conservation districts is governed. Qualifications of and terms of office for the members of both the state commission and the various county commissions are detailed. (Blunt-Fla) W69-01308

WATER REQUIREMENTS FOR INCREASED ARID LAND PRODUCTIVITY, For primary bibliographic entry see Field 02D.

For abstract, see . W69-01470

WATER IMPORT SYSTEMS FOR ARID LAND DEVELOPMENT.

Ralph M. Parsons Co., Los Angeles, Calif. For primary bibliographic entry see Field 06B. For abstract, see . W69-01471

SEEDING ANNUALS AND PERENNIALS IN NATURAL DESERT RANGE,

Hebrew University of Jerusalem; Volcani Institute of Agricultural Research, Newe Ya'ar Experiment Station

N. H. Tadmor, M. Evenari, and J. Katznelson.

J of Range Manage, Vol 21, No 5, pp 330-331, September 1968. 2 p, 1 tab.

Descriptors: Rainfall, \*Planting management, \*Descriptors: Railitali, Francing Handgen

\*Descriptors: Railitali, Francing Handgen

\*Descriptors: Railitali, Francing Handgen

\*Posteriors: Railitali, Fra \*Water spreading, \*Plant growth, management, Ranges, Moisture deficit. Identifiers: Israel, Negev Desert, \*Annuals,

\*Perennials.

An investigation was conducted in 1960-61 to study range seeding under desert conditions at the Avdat Desert Research Center in the central Negev of Israel. Seeding of pasture plants in a 78-mm rainfall desert resulted in complete failure of all perennials to establish themselves. Annuals, in spite of stunted growth, completed their life cycle and produced seed. Water-spreading was a prerequisite for successful establishment of perennial pasture plants under desert conditions. (Blecker-Ariz)
W69-01475

THE BREEDING OF SPINELESS CACTUS )OPUNTIA SPP( AS A DROUGHT RESISTANT FODDER CROP,

Research Institute of the Karoo Region, Middelburg, CP, Republic of South Africa.

G. C. de Kock.

Proc 9th Int Grassland Congr, Vol 2, pp 1459-1460, 1966. 2 p, 1 tab.

Descriptors: \*Plant breeding, \*Cacti, \*Drought resistance, Plant growth, Arid climates, Insect resistance, Semiarid climates, Seed treatment, Irradiation, Gamma rays, Crop response, Germination, Genetics, Forages.

Identifiers: Cross breeding, Nutritive value, Succulents, Spineless cactus, Republic of South Africa.

The Republic of South Africa has a breeding program which aims at the improvement of the spine-less cactus (Opuntia spp) with respect to drought resistance, fodder yield, palatability, nutritive value and insect resistance. Variations were obtained by cross-breeding and treating air dry seed of different spineless cactus cultivars with gamma rays. With the considerable variation obtained by the propagation of seed, gamma irradiation of seed and the treatment of seed with chemicals, it is possible to improve the cross-pollinated drought resistant spineless cactus fodder plant by selection and cross-breeding. (Blecker-Ariz) W69-01477

THE INFLUENCE OF GRAZING- AND CUTTING-TREATMENTS ON WATER USE UNDER PERMANENT PASTURES IN GER-MANY.

Bonn Univ, Institut fur Pflanzenbau, Germany H. G. Kmoch.

Proc 10th Int Grassland Congr, pp 137-140, 1967. 4 p, 1 fig, 3 tab.

Descriptors: Grazing, Arid climates, \*Pasture management, Pastures, \*Soil moisture, \*Plant growth, Nitrogen, \*Cutting management, \*Water utilization, Moisture uptake, Growth stages, Leaves, Root systems, Fertilizers, Rainfall. Identifiers: \*West Germany, Stems, Neutron Scatteries Matthed

tering Method.

A grazing experiment was developed to compare long-term effects of constant grazing or cutting at different stages of plant growth. Soil moisture was measured by the Neutron Scattering Method. The differences between stem-stage and leaf-stage decreased in dry years compared with wet years, as far as the first cutting was concerned. In arid parts of the world, the reduction in vigor of roots, and the subsequent diminished water uptake from the subsoil, was taken into consideration as a cause of overgrazing. It was hard to explain why dry periods of equal length and intensity sometimes brought great hazards to pasture production and sometimes did not. Nitrogen fertilization was considered in connection with its effect on the increased depth

and extension of the root system which could help to overcome dry periods. (Blecker-Ariz)

THE EFFECT OF SOIL MOISTURE REGIME AND NITROGEN APPLICATION ON THE PRODUCTION OF A PERRENNIAL PASTURE MIXTURE.

Department of Agriculture, South Australia, Australia. P. Judd

Proc 9th Int Grassland Congr, Vol 2, pp 1191-1197, 1966. 7 p, 5 tab, 21 ref.

Descriptors: \*Soil moisture, \*Arid climates, \*Nitrogen, \*Pastures, Fertilizers, Moisture tension, Clovers, Perennial ryegrass, \*Moisture stress, Water utilization, Pasture management, Rates of application, Crop response, Grasses, Irrigation effects, Productivity.

Identifiers: Dry matter, Quadrats.

An experiment was established at the Milang Irrigation Research Center in South Australia to gain better understanding of the use of nitrogen and water and their effects on pasture yield, botanical composition and general economics of production. Three soil moisture regimes (30 cm, 20 cm and 12 cm Hg tension) and three levels of nitrogen application (0, 98.4 and 295.2 lb N per acre) were applied during the summer to a perennial pasture. Clover was highly sensitive to moisture stress and was therefore at a competitive disadvantage as soil moisture stress increased. Ryegrass showed no response without nitrogen application. Total production and production per unit of water applied increased as soil moisture stress decreased. Fertilizer nitrogen, through the medium of grass production, increased the yield per unit of water applied and this compensated for moisture stress. The plants on a well fertilized arid range will make the most efficient use of the moisture available to them. (Blecker-Ariz) W69-01481

THE MANAGEMENT AND UTILIZATION OF SPINELESS CACTUS )OPUNTIA SPP(,

Research Institute of the Karoo Region, Middleburg, CP, Republic of South Africa. G. C. de Kock

Proc 9th Int Grassland Congr, Vol 2, pp 1471-1474, 1966. 4 p, 2 tab.

Descriptors: \*Cacti, Semiarid climates, Arid climates, \*Drought resistance, Droughts, Grazing, Contour farming, \*Browse utilization, Water conservation, Soil conservation, \*Forages, Vegetation establishment, \*Planting management, Nutrients. Identifiers: Succulents, Spineless cactus, Saltbush, Fodder, Republic of South Africa.

In arid regions of the Republic of South Africa, drought resistant fodder crops such as spineless cactus and Oldman Saltbush have been planted extensively and used as a source of feed and water reserves during droughts. Spineless cactus yields considerable quantities of succulent plant material under comparatively unfavorable climatic conditions and retains its succulence even during droughts. When planting is done on the contour, the plants serve as a wind break, reduce runoff and this way conserve both soil and water. Spineless cactus cultivars Monterey, Chico, and Robusta were used in the trials. (Blecker-Ariz) W69-01486

EFFECT OF DRYLAND LEVELING ON SOIL MOISTURE STORAGE AND GRAIN SORGHUM

Agricultural Research Service, Manhattan, Kansas.

Trans ASAE, Vol 10, No 4, pp 523-525, 1967. 3 p, 4 tab

Descriptors: \*Land forming, \*Dry farming, Growth stages, \*Soil moisture, Water utilization, Texas,

\*Water storage, Fallowing, Runoff, \*Sorghum, Topography, Crop response, Rainfall-runoff rela-tionships, Water table, Surface runoff, Sampling. Identifiers: \*Rio Grande Valley (Texas).

In the Lower Rio Grande Valley of Texas effects of leveling non-irrigated land on stored soil moisture and hybrid grain-sorghum were studied for three years at three paired sites. Even though leveled fields showed more stored moisture than nonleveled fields following runoff-producing rains in the fallow season, these differences largely disappeared by seeding time. At seeding time only about 6 percent of fallow-season rainfall was stored in the 6 ft soil profile. Average test period grain yields showed slight advantages of 50, 50, and 80 lbs per acre in favor of the leveled fields over non-leveled fields of sites 1, 2, and 3 respectively. Other possible advantages of non-irrigated land leveling were noted. (Affleck-Ariz) W69-01490

#### CONSERVATION BENCH TERRACES IN TEX.

Agricultural Research Service, Bushland, Texas. Victor L. Hauser.

Trans ASAE, Vol 11, No 3, pp 385-386, 392, 1968. 3 p, 3 fig, 3 tab.

Descriptors: \*Water conservation, \*Dry farming, \*Bench leveling, \*Terracing, Texas, \*Erosion control, Fine-textured soils, Soil water, Runoff, Crop response, Watershed management, Water storage, Wheat, Sorghum.

Identifiers: Water erosion, \*Conservation bench

The conservation bench terrace is a structure designed to conserve runoff water for crop use on dryland and to control water erosion. Ten years of research with farm-size fields at Bushland, Texas showed conservation bench terraces to be an improved terrace system for the fine textured soils of the Southern Plains. Bench terraces increased total crop production from a farm-size unity 1.5 times the production achieved by level terraces. Conservation benches stored more water than a benchleveled area and the same amount as level terraced fields after eleven months of fallow. (Affleck-Ariz) W69-01493

#### 04. WATER QUANTITY MANAGEMENT AND CONTROL

#### 4A. Control of Water on **THE Surface**

DISCUSSION OF AQUEDUCT CAPACITY UNDER AN OPTIMUM BENEFIT POLICY, Illinois Univ., Urbana.

S. Ramaseshan.

Amer Soc Civil Eng Proc, Vol 88, No IR2, pp 97-100. June 1962.

Descriptors: \*Aqueducts, Benefits, Digital computers, Distribution systems, \*Economic efficiency, \*Linear programming, Dynamic programming, Monthly, Multiple-purpose, Optimization, Reservoir design, Reservoir operation, Seasonal, Water distribution (Applied).

A linear programming model is presented which takes into account more facets of the aqueduct sizing problem than Hall's dynamic programming model. Monthly variations in inflow and outflow, a curvilinear cost function for the channel and reservoir and convex benefit function are used in the model. No overyear storage or overflow in a normal year is assumed. Physical constraints are placed upon the aqueduct flows, total outflows and the net storage in each time period. For 3 aqueduct sections, 3 ranges of benefit functions and 12 months, there are 276 equations with 274 slack

#### Field 04—WATER QUANTITY MANAGEMENT AND CONTROL

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variables and 108 real variables. A trial and error solution is required. Values for the flow in the 3 sections can be chosen by random sampling, systematic sampling or by the single factor method. It is suggested that by analysis of the model for different reservoir sizes, the optimum storage capacity can be determined. (Gysi-Cornell) W69-01206

#### PRODUCT-MIX ALTERNATIVES: FLOOD CONTROL, ELECTRIC POWER, AND IRRIGA-TION.

Stanford Univ., Palo Alto, Calif.

Alan S. Manne.

Int Econ Rev, Vol 3, No 1, pp 30-59, Jan 1962. 8 fig, 8 tab, 19 ref, 1 append.

Descriptors: \*Linear programming, Markov processes, \*Multi-purpose reservoirs, Economic efficiency, Optimization, Flood control, Electric power rates, Irrigation.
Identifiers: Economic trade offs.

Stochastic linear programming was used to determine the optimal operating policy of a single reservoir used for flood control, electric power, and irrigation. The probability of inflows into the reservoir were assumed to be uncorrelated. The model was assumed to have an infinite horizon. The objective was to maximize expected annual benefits subject to certain constraints of statistical equilibrium. A hypothetical example was solved. The conclusion was that the higher the level of storage capacity reserved for flood protection during the wet season, the lower became the expected hydroelectric benefits. Results were presented and analyzed in the form of product-mix curves and tables. An intrepretation of the dual variables was presented. Modifications were suggested in the model to account for head-height effects and benefits from irrigation. Comparison between the probabilistic and deterministic calculations are given in an appendix. (Gablinger-Cornell) W69-01208

#### THE USE OF STORAGE WATER IN A HYDROELECTRIC SYSTEM,

Massachusetts Institute of Technology, Cambridge John D. C. Little.

Oper Res Soc Amer J, Vol 3, No 2, pp 187-197, May 1955. 2 fig, 1 tab, 4 ref.

Descriptors: \*Dynamic programming, Reservoir operation, \*Hydroelectric power, Markov processes, Computer programs, Mathematical models, Optimization, Operating costs.
Identifiers: Grand Coulee Dam, Columbia River.

Stochastic dynamic programming was used to find operating rules of a reservoir used for hydroelectric production. The objective was to minimize the expected yearly cost. The state variables were current reservoir level and inflows into the reservoir in the preceding interval, the decision variables were the releases from the reservoir, and the stages were the time intervals. Probabilities of inflow were assumed to conform to a simple Markov process. The recursive relation was developed, and a mathematical model of the hydroelectric cost was presented. An example using data from the Grand Coulce Dam on the Columbia River was solved. The system was then operated with historical flow record as input and analyzed. The minima found were sometimes true minima and sometimes corner minima. (Gablinger-Cornell) W69-01209

#### STATISTICAL ANALYSIS OF THE RESER-**VOIR STORAGE - YIELD RELATION.**

Harvard Univ., Cambridge, Mass., Harvard Water Resources Group. For primary bibliographic entry see Field 06A

For abstract, see . W69-01210

THE OPTIMIZATION OF SINGLE-PURPOSE RESERVOIR DESIGN WITH THE APPLICATION OF DYNAMIC PROGRAMMING TO SYNTHETIC HYDROLOGY SAMPLES,

California Univ., Los Angeles. For primary bibliographic entry see Field 06A. For abstract, see W69-01222

#### PLANNING FLOOD CONTROL MEASURES BY DIGITAL COMPUTER,

University of Kentucky, Lexington. James N. Cline.

Res Rep No 11, Univ Kentucky, 1968. 313 p, 6 fig, 35 tab, 38 ref. OWRR Project A-001-Ky.

Descriptors: \*Computer programs, Computers, Computer models, \*Flood control, Analysis, Planning, Economics, Land use, Flood, Flood proofing, Flood protection, Design flood, Costs, Channel improvement, Hydrographs.

The purpose of this study was to develop adequate guidelines for using a pair of digital computer programs known as the University of Kentucky Flood Control Planning Programs to ease the computational burden of evaluating specific flood control situations. Program II determines the economically optimum combination of channel improvement, land use restriction, and flood proofing for flood damage abatement. Program III also incorporates reservoir storage into the planning process. The Programs are not intended to provide a finished design but rather to select the optimum combination of flood control measures and residual flooding with regard to both time and space. Application of Computer Programs to flood control planning is guided by presenting a general description of the application process and a detailed description of the input required and the output produced by the Planning Programs. Input was developed and results interpreted to determine the optimum flood control plan for the upper reaches of the North Fork of the Kentucky River near Hazard, Ken-W69-01268

#### BEY V WRIGHT PLACE, INC )DAMAGES FOR WATER DISCHARGE ONTO PLAINTIFF'S LAND(

State of Ohio, Columbus.

160 N E 2d 378-383 (Ct App Ohio 1956) 6 p.

Descriptors: Judicial decisions, \*Ohio, Damages, Discharge (Water), Rainfall-runoff relationships, \*Runoff, Surface waters, Ditches, Channels, Natural streams, \*Sewage, Watercourses (Legal), Wells, Streams, Beds, Banks, Drainage, Riparian

Action was brought for damages resulting from additional waters discharged onto plaintiffs' land by the defendants. The trial court ruled in favor of the plaintiffs, and the court of appeals affirmed. The owner of lower land must accept natural surface drainage from higher land. However, where surface water, when it rained, ran from higher land of the defendants over lower lands of the plaintiffs and then into a ditch, but there was never a watercourse, natural waterway, or other defined channel, the plaintiffs were not required to accept from the defendants' higher land additional water which had been pumped from deep wells, then used for toilets, washrooms, restaurant, and other business uses. This additional water was not surface water and the defendants were liable for damages caused by the additional waters on the land of the plaintiffs. One may not obtain by prescription, or otherwise than by purchase, a right to cast sewage on the lands of another without his consent. (Watson-Fla) W69-01276

#### LINCOLN PARK AMUSEMENT CO V TOWN OF WESTPORT )ACTION BY PROPERTY

#### OWNER TO COMPEL TOWN TO REOPEN CULVERT(. State of Massachusetts, Boston.

159 N E 2d 68-70 (Mass 1959) 3 p.

Descriptors: Judicial decisions, \*Massachusetts, \*Culverts, Roads, Surface drainage, \*Natural streams, Ponds, Rivers, Tributaries, Discharge (Water), Streams, Runoff, Flow, Riparian rights, Streamflow, Obstruction to flow.

This was an action by an amusement company to compel the town to reopen and maintain a culvert in good condition. The Supreme Court held that the finding by a master that water had flowed from the plaintiff's pond through the culvert to a tributary of a river from 1908 to 1954 supported the conclusion that the culvert had become a natural watercourse which the town had a duty to keep open. Even if the amusement park had no right to discharge effluent from a sanitation plant into the stream, the town was not justified in obstructing the culvert. However, a property has no right to materially increase the flow of water from his land so as to cause injury to downstream land owners. (Watson-Fla) W69-01277

#### RIGHT TO INUNDATE LAND AS RENDERING TITLE THERTO UNMARKETABLE, C. S. Patrinelis.

15 ALR 2d 966-967.

Descriptors: \*Flooding, Legal aspects, \*Market value, Judicial decisions

Identifiers: Reserved rights, Encumbered title.

The general rule is that title to land is rendered unmarketable where there is a reservation of rights or interest in the land incompatible with full enjoyment and ownership of that land. The vendor is not obligated to accept an encumbered title when there was no express exceptions to such reservations in the contract. There have been no departures from this general rule when the right reserved was to inundate land. (Sisserson-Fla) W69-01279

#### FREDERICK V UNION CARBIDE CORP )LIA-BILITY FOR FLOOD DAMAGE(. State of West Virginia, Charleston.

168 F Supp 808-811 (D C W Va 1959).

Descriptors: \*West Virginia, \*Judicial decisions, Water law, \*Flood damage, Flood gates, \*Negligent inundation, Streams, Culvert, Flooding, Damage, Water law. Identifiers: Act of God.

Plaintiffs allege that defendant's negligence in maintaining an improper floodgate and wire mesh fence over a stream impeded the flow of debris-carrying flood waters, causing the waters to dam up and rise into plaintiff's store. After defendant removed the flood gate and changed the location of the fence, subsequent floods of similar intensity failed to cause any backing up. The court held the flood not to be an act of God because reasonable human foresight, pains and care could have prevented the result. To relieve from liability, the act of God must be the sole and proximate cause of the injury. Defendant was held to be negligent because he failed to fulfill his duty which was stated as 'the exercise of reasonable care in the maintenance of a culvert (have a floodgate and fence) commensurate with size of the watercourse and with the area and character of the country that it must naturally drain.' (Childs-Fla) W69-01282

#### RIVER DEVELOPMENT CORP V LIBERTY CORP ) SUBAQUEOUS LAND RECLAMATION(. State of New Jersey, Trenton.

29 N J 239, 148 A 2d 721-722 (1959).

Descriptors: \*New Jersey, Judicial decisions, River beds, \*Land reclamation, Legislation, Permits, \*Ownership of beds.

Plaintiff held a statutory authorization or license to reclaim subaqueous land of a river and sought to enjoin the defendant from conducting dredging operations in the river. Since the license to reclaim the land had remained unexercised for a period of 86 years, any rights thereunder are held to have expired. Mere non-use is not sufficient to sustain a finding of abandonment. It is unreasonable to assume that the license to reclaim conferred a vested right in perpetuity in the subaqueous lands. By implication of law it must be assumed that the parties intended the receiver of the license to reclaim and acquire actual ownership of the fee within a reasonable time. (Molica-Fla)

## JOHNSTON V MILLER )ACCELERATED FLOW OF SURFACE WATER(. State of Ohio, Columbus.

240 NE 2d 566-569 (Ct App Ohio 1968).

Descriptors: Judicial decisions, \*Ohio, Damages, Tile drainage, Surface waters, \*Drainage systems, \*Erosion, Washouts, Natural flow.

In the lower court the plaintiff won damages and an injunction on the ground that the drainage system installed by the defendants had concentrated, diverted, and accelerated the flow of surface water across the plaintiff's land causing washout and erosion. The court of appeals held that whether or not surface water flowed naturally from the defendant's land or was diverted and concentrated by a tiling system was a jury question, and it would not reverse the decision of the jury. The court of appeals also stated that an upper land owner cannot lawfully increase the burden on lower lands by collecting surface water and discharging it in larger quantities and at points other than those established by natural drainage. (Watson-Fla) W69-01286

## DIMMOCK V CITY OF NEW LONDON )WRONGFUL DIVERSION OF WATER FROM BROOK(.

State of Connecticut, Hartford.

245 A 2d 569-574 (Conn 1968). 6 p.

Descriptors: Judicial decisions, \*Connecticut, Damages, Streams, Diversion, \*Riparian rights, Streamflow, Ponds, Channels, Water quality, \*Natural flow doctrine, Prescriptive rights, Invasion, Reservoirs.

Identifiers: Injunction, Equity.

The city successfully defended this action for injunction and damages in the trial court. On appeal it was reversed in favor of the plaintiff. This court held that a riparian owner is entitled to the natural flow of the water of a stream through or along his land, in its accustomed channel, undiminished in quantity and unimpaired in quality. Regardless of any perceptible, actual damage which a lower riparian plaintiff may be able to prove resulted from a wrongful diversion by an upstream defendant, such a diversion is an invasion of the rights of the plaintiff. If the invasion was continued for a period of 15 years it would confer a prescriptive right upon the defendant to divert the stream. Because the diversion of the water was necessary to supplement the public water supply and the plaintiff's damages were found to be nominal by the trial court, an injunction was granted and the city was allowed a reasonable time to make adequate compensation to the plaintiff. (Watson-Fla) W69-01287

## SEC 137 RAISING WATER SO AS TO INJURE MILL-SEC 138 INJURY TO DAM, RESERVOIR, ETC.

State of Massachusetts, Boston.

Mass Ann Laws Ch 266, Secs 137-138 (1967).

Descriptors: \*Massachusetts, Legislation, \*Dams, Reservoirs, Canals, Ditches, \*Water injury, Floods, Damages, Obstruction to flow, \*Mills. Identifiers: Crimes.

Sec 137 provides that whoever, by maintaining a dam, knowingly causes waters to rise so as to injure a lawfully existing mill, shall be punished by a fine of not more than \$1000 or imprisonment for not more than 6 months. This section shall not apply where the courts of the state have jurisdiction to abate the dam. Sec 138 provides that whoever intentionally injures a dam, reservoir, canal, mill, or any appurtenances thereto, or willfully draws off, or obstructs the flow from, any mill pond, reservoir, etc., shall be imprisoned for not more than 5 years or fined not more than \$500 and imprisoned for not more than two years. (Williams-Fla) W69-01290

## DIVISION OF WATER RIGHTS AND OTHER INCORPOREAL HEREDITAMENTS; PARTITION OF WATER IN A NATURAL STREAM, ETC.

State of Massachusetts, Boston. For primary bibliographic entry see Field 06E. For abstract, see. W69-01291

LIABILITY OF LANDOWNER FOR DAMAGES CAUSED BY OVERFLOW, SEE PAGE, OR THE LIKE RESULTING FROM DEFECT IN ARTIFICIAL UNDERGROUND DRAIN, CONDUIT, OR PIPE, W. R. Habeeb.

W. R. Habeeb. 44 ALR 2d 960-972.

Descriptors: Damages, Flood damage, \*Subsurface drainage, \*Subsurface drains, Conduits, Pipes, \*Legal aspects, Artificial watercourses, Surface drainage, \*Obstruction to flow, Construction. Identifiers: Defective construction, \*Ordinary care.

Jurisdictions were divided on the liability of landowners for damage resulting from defects in artifi-cial underground drains, conduits, or pipes. Decisions ranged from directed verdicts for either plaintiff or defendant. A number of jurisdictions held defendant to a duty of ordinary care, a question of fact, to see that no injury came to adjacent property owners. The general rule seems to be that a defendant landowner, whether upper, dominant, or controlling, or lower or servient, is liable for damage to adjacent property owner's land as a result of defective construction of artificial drains. An exception was when damages arose from extraordinary and unprecedented flows. City property owners may protect their land from surface water flowing from adjacent land, even if it involved obstructing an artificial drain. (Sisserson-Fla)

W69-01292

#### WHEN STATUTE OF LIMITATION COM-MENCES TO RUN AGAINST DAMAGE FROM OVERFLOW OF LAND CAUSED BY ARTIFI-CIAL CONSTRUCTION OR OBSTRUCTION,

E. H. Schopler. 5 ALR 2d 302-386.

Descriptors: \*Judicial decisions, Obstruction to flow, Waterway, \*Overflow, Flood damage, Drainage systems, \*Legislation, \*Natural flow, Eminent domain, Louisiana, Massachusetts, Embankments, Public utility, Cities, Railroads. Identifiers: Statute of limitations.

Two questions are presented concerning damage caused to land by artificial construction or obstruction which results in overflow: (1) when does the statute of limitations start to run, and (2) for what part of the cause of action does it run. Permanent and continuing injuries are distinguished as to their effect in starting the limitation period. The permancy, lawfulness, negligence in construction, and

removability of the obstruction are all factors in classifying the injury for purposes of determining the beginning of the limitation period. Four characteristic groups of cases are distinguished. The first two groups are concerned with whether the limitaperiod begins when the obstruction is completed or when, after such completion, injury caused by overflow becomes manifest. The last two groups of cases deal with circumstances by which successive injuries begin the limitation period for the entire cause of action or only for separate causes as and when they accrue. There is disagreement as to when the limitation period begins for acts by municipalities, improvement districts, private individuals or corporations or railroads. (Childs-Fla) W69-01298

#### CANAL COMPANIES. State of Georgia, Atlanta.

For primary bibliographic entry see Field 06E. For abstract, see . W69-01302

AN ACT TO AMEND...AN ACT CONCERNING THE ESTABLISHMENT, DEVELOPMENT AND OPERATION OF PUBLIC PORTS, CREATING THE INDIANA PORT COMMISSION AND DEFINING ITS POWERS AND DUTIES.
State of Indiana, Indianapolis.

Indiana Laws Ch 210 (1967).

Descriptors: \*Indiana, Legislation, \*Port authorities, Harbors, Navigation, \*Canal construction, Repairing, Condemnation, Cost repayment, Project planning, Administrative agencies, Public benefits.

This Act is an addition to chapter 11 of the Acts of the Indiana General Assembly for the year 1961. It adds to and defines new powers of the Indiana Port Commission. The commission is authorized to construct new canals, and repair and improve existing canals and waterways for the purpose of connecting ports under the commission's jurisdiction with other such waterways. The commission is not authorized to condemn any existing property right and is required to reimburse any public or private facilities for damage resulting from construction or repair of canals. (Sisserson-Fla)

AN ACT...TO CHANGE THE DEFINITION OF WATERS..., TO CHANGE THE DEFINITION OF POLLUTION, TO EXEMPT TIDAL WATERS..., CERTAIN DRAINAGE SYSTEMS FROM THE PERMIT REQUIREMENTS.
State of Maryland, Annapolis.

Maryland Laws ch 416 (1967).

Descriptors: \*Maryland, Legislation, Administrative agencies, \*Permits, Reservoirs, Dams, Obstruction to flow, Construction, Repairing, \*Water pollution, Tidal waters, Drainage systems, Administration.

Identifiers: \*Public hearings.

This Act repealed and re-enacted, with amendments, sections 2 (E), (G), 12 (A) and 15 of Article 96A of the Annotated Code of Maryland (1966 Supplement), title "Water Resources", subtitles 'General Provisions' and 'Appropriation of Waters, Reservoirs and Dams.' "Waters of the State' and pollution are defined. It is unlawful for anyone to construct or repair a reservoir, dam or water obstruction without a permit from the Department of Water Resources. Excepted from this requirement are: dams and obstructions under ten feet in height; reservoirs with a storage capacity of less than one million gallons; reservoirs constructed under a permit of the State Department of Health; structures impounding waters less than four feet in depth for the propagation of wildlife species; and drainage systems designed for collection, conveyance and

#### Field 04—WATER QUANTITY MANAGEMENT AND CONTROL

#### Group 4A-Control of Water on the Surface

disposal of storm water. Public hearings are mandatory for permit applications to alter, in any manner, the course of any waters of the state. (Sisserson-Fla) W69-01306

#### DUNLAP V HARTMAN )TITLE TO ACCRETION(.

338 S W 2d 10-13 (Mo 1960).

Descriptors: \*Missouri, \*Missouri River, \*Accretion (Legal aspects), \*Boundaries (Property), Remedies, Adjudication procedure, Judicial decisions

Identifiers: Quiet title, Adverse possession

Owners of land adjoining the Missouri River sought to quiet title to land formed by accretion between what had been an island owned by defendants and the mainland. The Circuit Court quieted title in plaintiffs and defendants appealed. This court held that whether the land had accreted to the mainland or the island was a question of fact, and affirmed the judgment. Similarly, whether or not defendants had acquired title by adverse possession was a question of fact. (Kahle-Fla) W69-01315

#### BACORN V STATE )OWNERSHIP OF NAVIGABLE RIVER BED(.

20 Misc 2d 369, 195 N Y S 2d 214-220 (1959).

Descriptors: Judicial decisions, \*New York \*Ownership of beds, \*Navigable rivers, Flood control, State jurisdiction.

Claimants brought suit against the state to recover money judgments for lands which they claimed were owned by them and were taken by the state without compensation. The state published notice of its taking of perpetual easements in two parcels of land on the Chemung River, for the purpose of the 'Elmira Flood Protection Project.' The state contended that the river was navigable and that its activities were restricted to the river hed. The claimants contended that the river had not been used for navigation for years and that even if it was a navigable river, the state's action had no relation to navigation. The Court of Claims found that the river was navigable and that the state had merely exercised public powers over public waters for which private interests must yield without compensation. The state's power is not restricted to regula-tion of navigation. Claimants failed to establish that the parcels were not in the river bed and the fact that such parcels were not subject to a continuous flow of water did not establish that they belonged to claimants through accretion. (R.F. Williams-W69-01316

## OWNERSHIP AND CONTROL OF WATER BOTTOMS AND CONTROL OF THE SHELLF-ISH INDUSTRY.

La RS 56: 421, 424, 425, 495 (1965).

Descriptors: \*Louisiana, Legislation, \*Administrative agencies, \*Commercial fishing, Shellfish, \*Ownership of beds, Rivers, Lakes, Bays, Gulf of Mexico, State governments, Judicial decisions, Leases, Coasts. Identifiers: Bi-valve industries.

The bottoms of bodies of water bordering on or connected with the Gulf of Mexico and all shellfish grown thereon are the property of the state. No conveyance of these bottoms can be made by any political official. The leasing of waters for mineral purposes is not affected. Water bottoms and natural reefs in waters of this state may be leased. No claim to any water bottoms suitable for oyster culture is valid until adjudicated as to the question of title. No lease of bedding grounds lawfully made before July 27, 1932, is affected by this act. Owners

of expiring leases have first right of renewal. The methods for granting leases to water bottoms and the regulations applicable after such lease has been made are provided by this act. The waters of Louisiana for purposes of the act are classified as either inside or outside waters. The pertinent factors for this classification are stated. This act is annotated. (Childs-Fla) W69.01320

#### UNITED STATES V MCFADDEN )ACTION TO OUIET TITLE(.

171 F Supp 628-631 (D C Ky 1959).

Descriptors: \*Kentucky, United States, Judicial decisions, Real property, \*Land tenure.

The United States brought an action to quiet title to a tract of land. Defendants, by counterclaim, sought to have title to a five acre portion of the tract quieted in them. At issue was the line between the government land and defendant's land. The deed to the government land called for the boundaries to follow the meanders of a stream. The defendant's deed called for a boundary in courses and distances. There was conflict between these two boundaries. Under Kentucky law, where a deed calls for the meanders of a stream as a boundary they must be followed and the courses and distances yield to the winding path of the stream where there is conflict. Thus, the United States was entitled to a judgment quieting title in it. (Childs-W69-01324

## COUNTY BOARD OF SUPERVISORS FOR MECOSTA COUNTY V DEPARTMENT OF CONSERVATION )TO ENJOIN LOWERING OF RESERVOIR LEVEL(.

160 N W 2d 909-927 (Mich 1968) 19 p.

Descriptors: Judicial decisions, \*Michigan, Reservoirs, Administrative agencies, Lakes, Streams, \*Water levels, Wildlife habitats, Riparian land, Riparian rights, Flow, Easements, Flooding, Legislation, Conservation, \*Dams, Fishing, Navigable waters, Impoundments.

The Supreme Court of Michigan ruled that an attempt by riparian owners to enjoin court determination of the height of an artificial lake was properly dismissed. The legislature did not intend to preclude the county supervisors from proceeding to have established the normal level of the lake which resulted from the construction and maintenance of a dam. The conservation department had acquired approximately two-thirds of all the riparian land involved and the remaining riparian owners had granted flowage easements to the state and had authorized the use of the water of the flooded area for public purpose. Therefore the action by the riparian owners to enjoin the conservation department from lowering the normal level by some 18 in. was properly dismissed. (R. H. Watson-

W69-01327

## MODERN STATUS OF RULES GOVERNING INTERFERENCE WITH DRAINAGE OF SURFACE WATERS,

W. E. Shipley. 59 ALR 2d 421-445.

Descriptors: \*Surface drainage, \*Drainage water, \*Legal aspects, Land tenure, \*Reasonable use, Relative rights, Obstruction to flow, Natural flow doctrine, Competing uses, Repulsion (Legal aspects), Civil law.

There were originally two basic rules applied by the courts in cases involving drainage of surface waters. The common enemy doctrine allowed the landowner to do anything he pleased on his own land in dealing with the disposal of surface water drainage, without liability to adjoining landowners.

The civil law rule, on the contrary, allowed no interference with the natural course of water drainage by landowners, and also prohibited artificial removal or increase of the water drainage. Both of these extreme views have been modified over the years. The tort principles of reasonable use and negligence have been applied by several states. Some courts have abandoned both rules and have adopted a third rule, the reasonable use doctrine, where the rights of the parties are determined by assessing all the relevant factors. These doctrines are most frequently called into use when the lower landowner dams back water, a landowner augments natural drainage, or when there are conflicts over the collection and discharge of water. (Sisserson-Fla) W69-01329

# RIGHT OF RIPARIAN OWNER TO CONSTRUCT DIKES, EMBANKMENTS, OR OTHER STRUCTURES NECESSARY TO MAINTAIN OR RESTORE BANK OF STREAM OR TO PREVENT FLOOD. 23 ALR 2d 750-761.

Descriptors: \*Embankments, \*Riparian land, \*Riparian rights, Floods, Flooding, Flood damage, Dikes, Levees, Natural streams, Watercourses (Legal), Banks, Water law, Legal aspects, Judicial decisions.

The annotation discusses the right of a riparian owner on a natural watercourse to construct embankments along his bank of the stream to protect his land. The general rule is that he does not have that right if the embankment constructed will cause ordinary flood waters to damage the lands of others. Some jurisdictions allow the construction of protective embankments and some jurisdictions hold that flood waters are surface waters and a common enemy against which a riparian owner may fight. The general rule only applies to damage to the land of others which is caused by ordinary flooding. If the embankment would not cause damage to another's land in times of ordinary flooding but would only in case of an extraordinary flood the embankment would be allowed. (Horner-W69-01330

#### 105-1407 WATERCOURSES: DIVERSION, OB-STRUCTION, OR POLLUTION AS CON-STITUTING TRESPASS 105-1408 UN-DERGROUND STREAMS, INTERFERENCE WITH.

105 Ga Code Ann secs 105-1407, 105-1408 (1967).

Descriptors: \*Georgia, Legislation, \*Riparian rights, Alteration of flow, Diversion, Obstruction to flow, Reasonable use, \*Natural flow doctrine, Streams, \*Underground streams, Water law, Legal aspects, Non-navigable waters, Overlying proprietor.

Sec 105-1407 provides that a riparian owner on a non-navigable watercourse is entitled to have its water come to his land in its natural and usual flow, subject only to reasonable use by other riparian owners. Diversion, obstruction or pollution of the stream, impeding its flow, causing it to overflow, or diminishing its value and thus causing injury to riparian land or a right appurtenant thereto, shall be a trespass to such riparian land. Sec 105-1408 provides that since the course of an underground stream and its condition before its first use are so difficult to ascertain, trespass may not be brought for alleged interference with the rights of an overlying proprietor. (R. F. Williams-Fla)

STANDARDS OIL CO )INDIANA( V JOINT BOARD OF SUPERVISORS OF HARRISON AND MONONA CTYS )EXPENSES OF

#### Control of Water on the Surface—Group 4A

RELOCATING PIPES NECESSITATED BY CHANGE IN DRAINAGE CHANNEL(. State of Iowa, Des Moines.

94 N W 2d 312-321 (Iowa 1959) 10 p.

Descriptors: Judicial decisions, \*Iowa, Channels, Administrative agencies, Drainage, \*Ditches, \*Pipelines, Drainage districts, Rivers, Permits.

Standard Oil sued the board to recover expenses incurred in relocating a pipeline necessitated by a change in a drainage channel by the district. An award was made in the lower court, but the supreme court reversed because the pipeline company, in application to the board of trustees of the drainage district for a permit to construct pipe line across the drainage ditch, had voluntarily offered to bear any expenses of relocating its pipeline necessitated by a change in the location of the drainage ditch. The pipeline company could not avoid its obligation to pay the expenses on the ground that the trustees were without power to accept the conditions. (Watson-Fla) W69-01339

## BELL V UNION ELECTRIC CO )FLOOD DAMAGE CAUSED BY DAM(. 367 S W 2d 812-822 (K C Ct App Mo 1963).

Descriptors: \*Flooding, \*Flood damage, Flood gates, \*Floods flow, Riparian land, Dams, Real property, Water levels. Identifiers: Flow retardation, Trespass.

The plaintiff claimed that a dam owned and operated by the defendant caused the flooding of his property and damage to his crops. The trial court found that where the flows of a river were retarded because of silt caused by a dam, and the presence of a lake held by the dam retarded the flow of the river and the operation of the floodgates of the dam and these factors combined to cause the flood waters going upon the plaintiffs' land, the dam owner is liable for damages caused by the flood. The court of appeals affirmed noting that the action was in the nature of a trespass and not negligence. (Horner-Fla) W69-01349

## TRUSTEES OF THE INTERNAL IMPROVEMENT FUND V VENETIAN ISLES DEV CORP) PERMIT TO DREDGE AND FILL(.

166 So 2d 765-768 (1 Dist Ct App Fla 1964).

Descriptors: \*Florida, \*Beds, \*Administrative agencies, \*Permits, Dredging, Bulkheads, Legal aspects.

The plaintiff corporation was issued a permit to dredge and fill certain bottomlands by the Pinellas County Water and Navigation Authority. The permit had been approved by the Trustees of the Internal Improvement Fund. Latter, the corporation filed an application with the Authority for an extension of the permit completion time. The Authority voted to extend the completion time. The Trustees never approved the extension and the plaintiff instituted action to determine the rights of the parties. The court held that the Authority properly exercised its powers in extending the permit, and, after doing so, its right to act ceased. The Trustees did not have the power to exercise independent judgment in this case and they were ordered to approve the extension. (Horner-Fla)

## **VOLKERDING V BROOKS )ACCRETION AND ADVERSE POSSESSION IN MISSOURI(.** 359 S W 2d 736-743 (1962).

Descriptors: \*Missouri, \*Accretion (Legal aspects), \*Boundaries (Property), Riparian rights, Riparian land, Water law, Judicial decisions. Identifiers: Adverse possession.

In an action to quiet title, the trail court held for the plaintiff as against the defendant's answers of title by adverse possession and by reason of accretion. However, on appeal, the court in the instant case reversed as to the issue of title by reason of accretion. The court stated that the law governing the matter held a riparian owner to own to the low water mark on navigable streams. Riparian ownership is essential to ownership of accretions, ie, accretions depend upon actual contiguity, without any separation of the claimant's land from the accumulated alluvion by the lands of another. A corollary of this rule is that if the shore lines of two bodies of land, such as islands, are divided by a watercourse, then receive accretions until the shorelines come together, the line of contact will be the division line. The court remanded the case because the evidence presented by the plaintiff was not sufficient to establish that his property extended to the water's edge. (Patterson-Fla) W69-01363

#### BLACK V CLARY )ACCRETION AND AD-VERSE POSSESSION IN ARKANSAS(.

364 S W 2d 528-530 (1963).

Descriptors: \*Arkansas, \*Accretion (Legal aspects), Legal aspects, \*Boundaries (Property), Riparian land, Judicial decisions. Identifiers: \*Adverse possession.

In affirming a ruling of the trial court judge enjoining the defendant from trespassing on the plaintiff's accreted lands, quieting title in the plaintiff and awarding damages, the court in the instant case stated that the result was justified on the basis of acquisition by accretion and by adverse possession. Upon reviewing the record as a whole, the court found that the plaintiff's possession had been both adverse and continuous for a period of seven years. It was also stated that notice of adverse possessions may be actual or inferred from facts and circumstances. (Patterson-Fla) W69-01364

#### PEOPLE V SPENCER )TITLE TO ACCRETED I AND(

5 Mich App 1, 145 N W 2d 812-816, (Ct App Div 3 Mich 1966).

Descriptors: \*Accretion (Legal aspects), \*Boundaries (Property), Judicial decisions, Water law, Legal aspects, \*Michigan.

This was an action to determine title to certain lands built up by accretion. During the time that the accretion was taking place on the two adjoining lakefront lots, both were owned by the same person. Subsequent to the accretion, part of the two lots was dedicated to the state as a public park, and the remainder was sold to the defendant. In Michigan, where the boundary of a piece of property is a shoreline, the shoreline is the boundary notwithstanding its subsequent recession or advancement. Where title to two lots was in a common owner, and the lots were added to by accretion, the common grantor may convey the new land without adherence to the new boundary established by accretion. The court held here that the grantor's intent controlled, and that the grantor intended to convey the accreted land to the defendant, hence relief was denied. (Batchelor-Fla) W69-01372

#### BOROUGH OF WILDWOOD CREST V MASCIARELLA )TITLE TO ACCRETED LAND(. 22 A 2d 138-145 (Super Ct N J 1966). 92 N J

222 A 2d 138-145 (Super Ct N J 1966). 92 N J Super 53.

Descriptors: \*Accretion (Legal aspects), Bank erosion, Boundaries (Property), Water law, Legal aspects, Judicial decisions, \*New Jersey.

This case deals with the question of whether the State or upland owners are entitled to gradual and imperceptible accretion. The court discusses the proposition that the owner of lands along the sea is obliged to accept the alterations of his boundaries. A distinction is then drawn between accretion by natural forces, and that which is artificially caused. While recognizing that natural accretion inures to the benefit of upland owners the court treats this as a case of first impression as to artificial accretion. After a discussion of authorities in other jurisdictions the court concludes that the better rule is that the alluvion formed by gradual and imperceptible accretion, whether caused in whole or in part by artificial means, inures to the benefit of the upland owner. Finally the court places two limitations on this rule. The first restriction applies when the artificial accretions are caused solely by the act of the upland owner. The record involves projects by a governmental agency in the aid of navigation. (Batchelor-Fla) W69-01373

#### JONES V WILLIAMSON )DRAINAGE EASE-MENT(.

220 N E 2d 645-648 (3d Dist Ct App 111 1966). 74 111 App 2d 367.

Descriptors: \*Easements, Legal aspects, Water law, Ditches, Diversion structures, Surface drainage, \*Surface runoff, Drainage water, \*Illinois.

This case deals with the construction of a drainage ditch to dispose of surface water runoff. The upland owner and the adjoining lower land owner agreed orally to the construction of this ditch. The lower land was then sold to Jones, who had no knowledge of the agreement. Jones now seeks to enjoin the upland owner from discharging surface water from the diversion ditch onto the lower property. It is acknowledged that an upland owner does not have a right to discharge water from a ditch onto lower land merely because he is the owner of upper land. The court then goes into the application of an 111 statute pertaining to construction of drainage ditches by mutual consent of the owners. The case holds that where a drainage ditch, constructed by mutual agreement, forms a continuous line across adjoining lands a perpetual easement exists on such lands. It is further held that where there are open visible marks of a drainage ditch easement the purchaser has a duty of inquiry and is bound by such easement. (Batchelor-Fla) W69-01374

## FREESTATE INDUSTRIAL DEVELOPMENT CO V T AND H INC ) OBSTRUCTION TO NATURAL FLOW OF SURFACE WATERS(. 188 So 2d 746 (La Ct App 1966).

Descriptors: \*Remedies, \*Louisiana, \*Surface drainage, Construction, \*Alteration of flow, Relative rights, Adjudication procedure, Natural flow doctrine, Legislation.

Plaintiff sought injunctive relief to prohibit defendant from altering the natural flow of surface drainage so as to cause drainage from defendant's property to flow upon plaintiff's property. In the alternative plaintiff prayed for compensatory damage. Prior to April, 1964 there was a ridge on defendant's property near the common boundary line of plaintiff's property which caused the major portion of surface drainage to flow away from plaintiff's land. Subsequently defendant made improvements on his property which plaintiff alleges caused surface water to flow onto his property. The lower court dismissed plaintiff's alternative demand for damages because the prescriptive period of one year had lapsed. This court reversed and remanded holding that plaintiff sought damages only in the event that injunction was denied. It is an established principle in Louisiana that compensatory damages may be awarded in lieu of injunctive relief. Such damages are not subject to the prescriptive period found in Articles 3536 and 3537 of the Louisiana Revised Civil Code. (Kahle-Fla)

#### Group 4A - Control of Water on the Surface

W69-01376

CLEMONES V ALABAMA POWER CO )FLOODING CAUSED BY DAM CONSTRUC-CO TION(.

250 F Supp 433-439 (N D Ga 1966).

Descriptors: \*Georgia, Legal aspects, Judicial decisions, \*Flood damage, Backwater, Dams, Reservoirs, Rain, Excessive precipitation, Floods, Public utilities

Identifiers: Act of God.

This is an action for damages against an electric utility for the flooding of plaintiff's property behind the utility's recently constructed reservoir after heavy rains. The facts showed that the defendant had made a detailed study of flooding in the area prior to the construction of the facility and this gave them a reasonable warning of the likely recurrence of flooding. Consequently, under Georgia law the heavy rains which transpired were not so extraordinary as to free the defendant of all liability. The acts and omissions of the defendant constitute a trespass by human agency even though coupled with acts of God. As a trespasser the defendant is liable for harm caused by it, and this liability is the apportioned amount of damage to the plaintiff not caused by the act of God. (P. N. Smith-W69-01382

#### IN RE BUREAU OF WATER SUPPLY )RESER-VOIRS AND NATURAL FLOW(.

219 A 2d 409-413 (N J 1966).

Descriptors: Rivers, Navigable waters, Salinity, Utilities, \*Water utilization, \*Water quality, Wastes, Flow control, Reservoirs, Contracts. Identifiers: Minimum flow rate.

In 1918, New Jersey approved the application of the water company to divert water from state rivers, subject to the condition that if it became necessary to provide storage of storm waters to supply consumers the expense would be apportioned among the consumers using water from the rivers. Subsequently, reservoirs were built to hold storm waters in order to provide minimum flow rates in the rivers and to supply consumer needs. The petitioner, water company, contended that the 1918 grant was a franchise which gave it a vested interest in the water and that it should not have to pay a portion of the cost of the reservoirs and that if it did have to pay, the amount should be reduced by the portion of the project that went toward maintaining minimum flow rates. The court held that the petitioner had agreed to pay a proportion of the cost of the reservoirs and that the maintenance of minimum flow rates benefited the water consumers by keeping the rivers clean and reduced salinity. (Horner-Fla) W69-01387

## ROBINSON V HUMBLE OIL AND REFINING CO )EFFECT IN CHANGE IN LOCATION OF STREAMBED ON BOUNDARY(.

176 So 2d 307-319 (Miss 1965).

Descriptors: \*Accretion (Legal aspects), \*Avulsion, Boundaries (Property), Real property, Meanders, Channels, Alluvial channels, Erosion, Riparian rights, Riparian land, Water law, Legal aspects. Identifiers: Evidence, Proof of facts.

The litigation concerned the title to a parcel of land situated between the old and the present bed of a stream. The stream was the original boundary between the land of the complaintant and that of the defendant. The complaintant alleged that the change in the stream was by avulsion and therefore the boundary did not change from the old stream bed. The court held that the evidence supported the chancellor's conclusion that the change was caused by accretion and that the boundary changed with the stream. The owners of land bounded by a stream own to the thread of the current of the stream; but the boundary shifts with gradual nonavulsive changes in the stream. In the absence of countervailing evidence, the presumption of gradual erosion and accretion prevails when the lay of the land, the length of elapsed time as related to the distances of the movement and the general correspondence of the location and directions of the river at the later period as compared with that of the earlier, are such that the stated presumption may be reasonably entertained. (Horner-Fla) W69-01391

#### PADGETT V CENTRAL AND S FLA FLOOD CON DIST )EFFECT OF LOWERING WATER LEVEL ON RIPARIAN TITLE(.

178 So 2d 900-905 (2 DCA Fla 1965).

Descriptors: \*Florida, \*Accretion (Legal aspects), Riparian rights, Riparian land, Boundaries (Property), Real property, High-water mark, Banks, Lakes, Water levels. Levees.

The controversy involves the rights of the defendant landowner whose property was situated on the bank of Lake Okeechobee until the state lowered the level of the lake thereby leaving a strip of land between the property and the lake. The state constructed a levee on that strip of land thereby depriving the plaintiff of access to and a view of the lake. The land presently belonging to the defendant was reclaimed land which had originally belonged to the state. The court held that the statute authorizing the conveyance to the defendant gave the state the right to change the status of the defendants lands so that they would no longer be lands with riparian rights. Where the state causes the level of a navigable lake to be lowered and thereby uncover lands below the original high water mark, lands so uncovered continue to belong to the state and do not vest in the riparian owner through the doctrine of accretion. (Horner-Fla) W69-01393

#### DRAINAGE PROBLEMS IN AN AREA CHANG-ING FROM RURAL TO URBAN,

Robert W. Brannan.

Pub Works, Vol 93, p 10, 1962.

Descriptors: \*Land use, Drainage systems. Identifiers: \*Urban drainage.

Gives some discussion on economic losses due to urbanization and poor drainage for Lucas County, Ohio. Also regulatory control methods that should be considered W69-01523

#### NATURE AND SCOPE OF SURFACE DRAINAGE IN EASTERN UNITED STATES AND CANADA,

E. W. Gain.

Am Soc Agric Engrs-Trans, Vol 7, No 2, pp 167-9,

Descriptors: \*Surface drainage, \*Design. Identifiers: Interceptor sewers, United States,

Review of basic surface-drainage systems now in use includes 'random', 'bedding', 'regular' or 'parallel ditch', 'interception', and 'diversion' systems. W69-01524

#### NEW YORK STATE MUNICIPAL WATER AND SEWAGE.

R. D. Hennigan.

Water Sewage Works, Vol 110, No 12, pp 448-52, Dec 1963.

Descriptors: \*Planning, Construction, \*Legislation, Grants.

Identifiers: \*Storm sewers, Urban drainage, New

The need for a unified approach to the planning, construction, and operation of all water utility services is stressed. In particular, water service, sewer service, and storm drainage projects should be planned on an integrated basis. New York State laws and constitutional changes have been designed to encourage an integrated approach to the planning of water and sewage works. Recent legislation relating to such planning is described. One provision would enable municipalities to obtain 100% support for approved comprehensive sewer and water studies. The author observes that 'counties are increasingly becoming the focus for providing area-wide water and sewer facilities.' A brief listing of sources of fiscal aid is included. W69-01525

#### ATTENUATION OF FLOOD WAVES IN PART-**FULL PIPES,**

P. Ackers, and A. J. M. Harrison.

Proc Instn Civ Engrs, Vol 28, pap No 6777, pp 361-381, 1964.

Descriptors: Pipes, \*Hydrographs, \*Floods, \*Con-

Identifiers: Storm sewers.

In the derivation of improved methods for designing storm-water drainage systems it is important to know the way in which the flood hydrograph (or flood wave) is modified as it passes along a conduit under conditions of free surface flow; and an extensive study was therefore carried out using an experimental pipeline installation in which the slope. height, and length of peak of the input hydrograph could be varied. For each set of conditions, depthtime data were automatically recorded and analysed in terms of dimensionless parameters, showing that the rate of lowering of the wave peak with time and with distance is a function of the pipe diameter, the Froude number, the depth of base flow, and the volume of fluid in the wave. The volume of the wave, not its shape, is the principal factor affecting the attenuation. The velocity of the peak of the wave was found to be in good agree-ment with the Kleitz-Seddon law. The peak depth of the wave is a function of the peak discharge, which is related to the steepness of the wave, but in most practical cases differs little from the normal discharge. As dimensionless parameters were used, the results are applicable to storm sewers of all diameters and floods of all durations and magnitudes, provided the hydrograph is not steeper than those studied. W69-01552

#### APPLICATION OF STORAGE ROUTING METHODS TO URBAN HYDROLOGY,

A. P. Aitken.

Instn Engrs, Australia J, Vol 40, No 1-2, pp 5-11, Jan-Feb 1968

Descriptors: \*Storm runoff, Design, Design storm. Identifiers: \*Urban drainage.

Methods of runoff routing developed in Great Britain and in United States are examined and extended in application, so that results may be applied as correction to 'rational method' of design; rational method is specifically derived for localities like Victoria and Great Britain, where runoff from pervious area for design storm is of no significance, but it could be applied in other areas with suitable modifications.

#### DRAINAGE AND BEST USE OF URBAN LAND,

Louis H. Antoine, Jr.

Pub Works, Vol 95, p 2, Feb 1964.

Descriptors: \*Land use. Identifiers: \*Urban drainage, \*Surface permeability, St. Louis (Mo.).

#### Effects on Water of Man's Non-Water Activities - Group 4C

This article discusses a study of drainage channels for the St. Louis area and gives data on the percent of imperviousness for different urban land uses. W69-01559

DETERMINATION OF RUNOFF FOR URBAN STORM WATER DRAINAGE SYSTEM DESIGN, K. W. Bauer.

Southeastern Wis Rge Plng Comm Tech Rec, Vol 2, No 4, April 1965. 19 pp.

Descriptors: \*Storm runoff, \*Design, \*Planning, \*Drainage systems, \*Rainfall intensity, Runoff. Identifiers: \*Urban drainage, \*Storm sewers.

Storm water runoff determinations are made to determine design criteria for the planning and design of urban drainage systems. The storm water runoff determination criteria is the rational method whose variables are: the coefficient of runoff, rainfall intensity for the area, time of concentration, and soil information. The application of these criteria should promote common storm sewer design methods and the adoption of common design methods for storm water drainage system design. W69-01560

#### RAINFALL AT NEW ORLEANS AND ITS REMOVAL,

G. G. Earl.

Civ Eng, Vol 2, No 5, pp 289-94, May 1932.

Descriptors: \*Drainage, \*Pumping, \*Discharge (Water), Storms, \*Rainfall intensity, Rain gages. Identifiers: \*Capacity, New Orleans (La.).

Drainage and sanitation problems; pumping capacity required to discharge accumulation of water in reasonable time; records of storm; drainage pumping stations; effects of irregular rainfall; new type rainfall recorder; extending rainfall data; sanitary systems. W69-01568

#### 4B. Groundwater Management

#### ECONOMIC CONTROL OF GROUNDWATER RESERVES,

Missouri Univ., Columbia.

Oscar R. Burt. J Farm Econ, Vol 48, No 3 Part 1, pp 632-647, Aug 1966. 1 fig, 14 ref.

Descriptors: \*Dynamic programming, Aquifers, Distribution patterns, Synthetic hydrology, Water balance, Water allocation (Policy), Public benefits, Economic efficiency, Markov processes, Groundwater recharge, Groundwater mining, Pumping, Marginal return.

Identifiers: Present value.

Sequential decision theory was used to develop a framework for derivation of optimal groundwater policies focused on temporal allocation. The functional equation was derived from a dynamic programming formulation of the problem. The primary criterion of choice was expected present value of net output from the basin, and dispersion of net output is introduced as a secondary consideration. The expected-present-value function and its associated rate-of-use function under an optimal policy were discussed, assuming that some form of tax method' could be applied to assure that the value-marginal-product function of the producers equalled the marginal-social-benefit function. The decision variables, the rates of use from stock, were functions of the storage level, time, and the rate of recharge, a random variable. Only discrete values of rates of use and storage were permitted. A Markov process analysis of groundwater stocks was presented. (Gysi-Cornell) W69-01207

OPTIMAL RESOURCE USE OVER TIME WITH AN APPLICATION TO GROUND WATER, California Univ., Davis, California.

For primary bibliographic entry see Field 06A For abstract, see .

#### TEMPORAL ALLOCATION OF GROUND-WATER, Missouri Univ., Columbia.

For primary bibliographic entry see Field 06A. For abstract, see. W69-01220

## STORAGE OF FRESH WATER IN UNDERGROUND RESERVOIRS CONTAINING SALINE WATER: PHASE I,

Kansas University, Lawrence For primary bibliographic entry see Field 02F. For abstract, see W69-01229

## SPERRY RAND CORP V WATER RESOURCES COMM'N )REMEDY FOR DAMAGE TO GROUNDWATER SUPPLY(.

291 N Y S 2d 716-718 (Sup Ct 1968).

Descriptors: \*New York, \*Administrative decisions, \*Well permits, Water law, Judicial decisions, Legislation, Water supply. Identifiers: \*N Y Water Resources Commission,

Public interest

The petitioner Sperry Rand Corporation seeks in this action an annulment of a determination of the New York Water Resources Commission permitting a landowner adjacent to the petitioner to utilize well water in a certain way. In granting the application of the adjacent landowner to sink the well in question, the Commission found that the petitioner might thereby be damaged; and the question in this case is whether the Commission must either refuse an application or impose protective conditions when a proposed use will have an adverse effect upon an adjoining owner. The court held that although such an adverse effect should be a factor for the Commission's consideration, its concern by statute was primarily with the public interest and not with the competing interests of two adjacent landowners. Redress for grievances between such landowners should be found in litigation interse se. (Patterson-Fla) W69-01346

#### ADAMS V GRIGSBY )INTERFERENCE WITH GROUNDWATER SUPPLY(.

152 So 2d 619-624 (La 1963).

Descriptors: \*Groundwater, Wells, \*Louisiana, Judicial decisions, Legislation, Percolating waters, Damage, Relative rights, Pumping, Groundwater mining, \*Overlying proprietor, Water sources, mining, \*Overlying proprietor, Water sources, Water supply, \*Water wells, Draw down. Identifiers: Injunction, English rule, Damages

(Legal aspects), American rule, \*Fugitive sub-

This was an action by residential property owners, who obtained water from a common underground source, for an injunction and damages against defendant for alleged wrongful depletion of the water supply by excessive pumping. Defendant sunk wells and pumped large quantities of subterranean fresh water for use in his oil recovery operations. The court denied plaintiffs' claims. The court rejected plaintiff's contention that underground waters were covered by articles of the Louisiana Civil Code dealing with drainage and the use of running water. The court held that groundwater, like oil and gas, is a fugitive substance, and hence belongs to whoever captures and makes use of it. Hence plaintiffs have no cause of action where defendant, by pumping groundwater from wells on his own land, reduces plaintiffs' supply from the common underground source. The court rejected both the English Rule, (owner owns and may use ground water, but not so as to injure his neighbor) and the American Rule (correlative rights). The court indicated that had defendant wasted the water, relief would have been granted. (Kirkconnell-Fla) W69-01350

#### THE EFFECT OF PUMPING OVER AN AREA.

Colorado State Univ, Fort Collins.

Robert E. Glover.

Symp Amer Water Resour Ass, San Francisco, Calif, pp 149-156, Nov 1967. 8 p, 1 fig, 4 ref.

Descriptors: \*Drawdown, \*Water table, \*Ground water, Aquifers, Theory, Areas, Pumps, Wells, Observation wells, Estimating, Forecasting, Charts, Geometric shapes.

Identifiers: \*Pumping, Groundwater depth, Formulas, Pumping tests, Groundwater movement.

Lowering of the water table caused by pump operation can be estimated in terms of drawdown at a corner of a rectangle over which the pumping is uniformly distributed. A chart gives the drawdown at a corner in terms of the width to length ratio and a dimensionless parameter involving the length, aquifer constant, and time. Drawdown at selected points either inside or outside the area of interest can be estimated by adding, or adding and subtracting, the drawdown produced by pumping over suitably chosen rectangles. A pumped area of irregular shape can be represented approximately by the sum of rectangles. To determine total drawdown at a selected well, the drawdown produced by the well discussed in this paper must be added to the drawdown produced by distributed pumping. (LISBR) W69-01415

#### FIELD OBSERVATIONS COMPARED WITH DUPUIT-FORCHHEIMER THEORY FOR MOUND HEIGHTS UNDER A RECHARGE BASIN.

Agricultural Research Service, Fresno, California. For primary bibliographic entry see Field 02F For abstract, see W69-01492

#### 4C. Effects on Water OF Man's Non-Water Activities

#### BAYSHORE V STECKLOFF )RIGHT TO FILL **BAY FRONT LOTS(.**

State of Florida, Tallahassee

107 So 2d 171-175 (3d D C A Fla 1958).

Descriptors: \*Florida, Judicial decisions, Legislation, Riparian rights, Ownership of beds, \*Landfills, \*Bulkheads, \*Coastlines, Beds, Shores, Bays.

Plaintiffs and defendants have adjoining bay front lots. Plaintiffs' lots were filled in and bulkheaded. Subsequently, defendants sought to fill in and bulk-head their lots as permitted under Fla Stat sec 271.01 (1955). Plaintiffs sought a declaratory decree to prevent defendants' action, which would close off the south waterfront side of their lots, on the basis of ch 57-362, Laws of Fla, which repealed the 1955 statute and on the grounds that they have acquired riparian rights on the lateral sides of their lots. The question of whether plaintiffs have acquired riparian rights on the lateral sides of the filled land does not need to be answered because the defendants are also entitled to fill in their lots pursuant to the 1955 statute. By provision the defendants are exempted from the effect of the 1957 statute. (Molica-Fla) W69-01281

U S V HARRISON COUNTY, MISSISSIPPI )SUIT BY U S TO END DISCRIMINATION AT PUBLIC BEACH BUILT WITH FEDERAL GRANT(. 399 F 2d 485-492 (5th Cir 1968). 8 p.

#### Field 04-WATER QUANTITY MANAGEMENT AND CONTROL

#### Group 4C - Effects on Water of Man's Non-Water Activities

Descriptors: Judicial decisions, \*Mississippi, Beaches, Sands, \*Recreational facilities, Sea walls, Grants, \*Federal government, Financing, Accretion (Legal aspects), Littoral, Riparian land. Identifiers: Injunction, Artificial accretion.

The court of appeals reversed the trial court and held that a sand beach and sea walls built with aid of federal funds must be available to all of the general public because it was so stipulated in the The decision of the Mississippi Supreme Court that artificially made sand beaches belonged to the owner of the adjacent property by artificial accretion was held not to be res judicata as to the rights of the U S in this case. The circuit court of appeals in this case held that the Miss Constitutional provision that lands belonging to the state shall never be donated to private persons superseded and abrogated the common law doctrine of artificial accretion. In dicta the court stated that the use of publicly owned beaches is subject to reasonable regulations by the state in exercise of its police powers and such public use must be enjoined in compliance with all valid laws of the state. Also that public use of beaches cannot unreasonably interfere with the littoral rights of the adjoining landowners. (Watson-Fla) W69-01288

TAKING OF LAND, ETC., FOR PUBLIC ACCESS FACILITIES, ETC., TO COASTAL WATERS AND GREAT PONDS. State of Massachusetts, Boston.

Mass Ann Laws Ch 21, Sec 17A (1967).

Descriptors: \*Legislation, \*Massachusetts, Coasts, Great ponds, Administrative agencies, Natural resources, Recreation, Parks, \*Eminent domain, Docks, \*Road construction, Land. Identifiers: Coastal waters.

The Department of Natural Resources is directed, after notice in writing signed by the chairman of the public access board, and with the consent of the governor, to take by eminent domain or to acquire by purchase, lease or otherwise, the land and water areas designated by the board. These lands are to be used to provide public access and related facilities to coastal waters and great ponds. The department is also directed to construct and maintain roads, parking areas, docks, ramps and related facilities as the public access board may designate. The cost of the acquisition, construction, and maintenance is chargeable to the public access fund. (Watson-Fla) W69-01295

#### SCHLOOP V NEW YORK )LIABILITY FOR FLOOD DAMAGE(.

190 NYS 2d 96-99 (Ct cl 1959).

Descriptors: \*New York, Judicial decisions, \*Flood damage, Lakes, Inland waterways, \*New York State Barge Canal, Legislation, Dams, Waterlevels, Navigation, Gates, Outlets, Reefs, \*Flood control

Plaintiff claims damages alleged to have been caused by waters overflowing Oneida Lake. Oneida Lake and its outlet are part of the Barge Canal system. The question is whether there is liability for the damage. Damages caused by a public improvement, such as a canal, are not recoverable in the absence of trespass or negligence. At the close of the navigation seasons the Taintor gates were open wide in the lake outlet. There were no works or construction by the state restricting the flow of water. The restriction was caused by a natural formation, the Caughdenoy reef. The state had no obligation to remove this reef. Claimant's land would have been flooded if nothing had been done by the state. Since the state was using the lake and outlet for canal purposes only, the state was under no obligation to exercise flood control. Since there was no negligence or trespass by the state, claimant cannot recover. (Childs-Fla)

W69-01325

REED V NEW YORK )FLOOD DAMAGE(. State of New York, Albany.

188 NYS 2d 760-761 (Ct cl 1959).

Descriptors: \*New York, Judicial decisions, \*Flood damage, Flood control, \*Canals, \*Culverts, Pipes, Water levels.

After a rainstorm, the water in an unused portion of a canal overflowed the banks causing damage to the property of claimants. The state had filled in the canal bed at one place to provide a roadway over the canal. Two pipes were placed under the roadway to provide for the flow of water. The state had notice of overflowing after the filling of the canal bed. The court found that the state failed to exercise ordinary care and maintenance by reason of the culverts either being clogged or inadequate. If the culverts were open and the state failed to open the gate valve to the lower level of water in the dam below, then they failed in their duty of reasonable care. Judgment was entered for claimants. (Childs-Fla) W69-01326

VALIDITY OF PROHIBITION OF BATHING, SWIMMING, BOATING, FISHING, OR THE LIKE, TO PROTECT PUBLIC WATER SUPPLY, C. C. Marvel. 56 ALR 2d 790-796.

Descriptors: \*Legislation, Administrative agencies, \*Regulations, Boats, Fishing, Swimming, Public health, Judicial decisions, \*Water supply, Water quality, Water utilization, Condemnation, Ownership of beds, Riparian rights, Water rights, Water law

The validity of statutes, ordinances, or administrative regulations which regulate or prohibit boating, fishing, or swimming in any kind of waters, public or private, in order to protect public water supplies is questioned. As applied to members of the general public, such regulations have been generally upheld as a valid exercise of the police power Where such regulations adversely affect private rights, whether dependent upon the ownership of the bed, or upon riparian ownership, the courts have been divided in their decisions with respect to the validity of such prohibitions. If there is a substantial infringement on the individual's riparian rights the courts generally require the state to resort to a condemnation action and compensate thw owner for such loss. The validity of such regulations is also affected by any reservation of rights, or failure to reserve rights, by one granting water rights to a public agency. (R. Smith-Fla)

JOHNSON V IOWA STATE HIGHWAY COMM'N )SUIT TO RESTRAIN COMMISSION FROM BUILDING 5 PAVEMENT INTAKES WHICH WOULD DIVERT SURFACE WATER ONTO PLAINTIFF'S LAND(. State of lowa, Des Moines.

94 N W 2d 773-778 (lowa 1959) 6 p.

Descriptors: Judicial decisions, \*Iowa, Roads, Administrative agencies, Surface waters, \*Surface runoff, Highways, Road construction, Diversion, Paving, \*Intakes, Damages, Drainage systems, Legislation, Natural flow doctrine, Culverts, Ditches, Erosion, Spillways.

Landowners brought actions against the State Highway Commission which was widening and repairing a highway, to restrain allegedly illegal diversion of surface water onto the plaintiffs' land through five pavement intakes. The trial court entered decrees closing 3 intakes on one side of the road but refused to close the 2 intakes on the opposite side of the road. This court affirmed, stating that the construction of the drainage system will

turn the natural drainage of some of the surface water, to the injury of the plaintiffs, and will thereby violate the defendants' statutory duty to drain the surface water from public raods in its natural channel. On this basis the court affirmed the closing of 3 of the intakes. The other 2 intakes would cost additional surface water on the plaintiffs' land but not enough to justify greater relief. It was also noted that it appears to be customary and in harmony with good engineering practices and definitely in the interests of the traveling public to place intakes and spillways where they will quickly take the accumulations of water off the pavement. (Watson-Fla)

BROWN V SCHOOL DIST )DAMAGE BY DIF-FUSED SURFACE WATER(. 161 S E 2d 815-817 (S C 1968).

Descriptors: \*South Carolina, \*Surface runoff, \*Surface drainage, Local government, Judicial decisions, Cities, Drainage, Damage, Water injury, Eminent domain, Surplus water, Precipitation excess, Storm drains, Water law, Surface waters, Legislation.

Identifiers: Catch basins, Streets, Just compensation, Cause of action.

This was an action by landowners asking actual damages for allegedly causing surface waters to be wrongfully concentrated and discharged onto plaintiffs' land. The school district built a school building across the street from plaintiffs' house. Plaintiffs' alleged that the construction of this building concentrated and discharged surface waters across the street and onto plaintiffs' property, and that the city did not provide proper drainage along the street as required by statute. The complaint admitted that the city had installed a catch basin in the street, but alleged that it was inadequate to handle all the water. The court held that the complaint stated a cause of action against the school district but not the city. Action by the city did not cause plaintiffs' injury. Action by the school board under statutory authority which effectively destroys or impairs the usefulness of private property amounts to a taking requiring just compensation. (Kirkconnell-Fla) W69-01342

#### STATE V PENNSYLVANIA RR )LOCATION OF MEAN LOW WATER MARK(.

244 A 2d 80-85 (Del 1968).

Descriptors: \*Delaware, \*Low water mark, \*Boundaries (Property), Water courses (Legal), \*Water level fluctuations, Ownership of beds, Tidal effects, Legal aspects, Judicial decisions, Surveys, Land fill, Railroads.

Identifiers: Burden of proof.

The defendant railroad had filled in land bordering the Delaware River. The question presented was whether the defendant railroad had filled beyond the mean low water mark. The State of Delaware claimed that on the basis of surveys made in 1942 and 1954 the defendant had filled some areas beyond the mean low water mark and thus title to this land was in the state. The defendant claimed that the state had the burden to prove the accuracy of the earlier surveys by a preponderance of evidence. The court held that the 1967 survey was more accurate and the state had failed to establish the accuracy of the earlier surveys. The present coastline must be used where it is exceedingly difficult or impossible to determine the mean low water mark of the distant past. (Kirk-Fla) W69-01345

ANDERSON V SUPER )OBSTRUCTION OF A DRAINAGE EASEMENT(.

28 111 2d 319, 192 N E 2d 339-341 (1963).

#### Effects on Water of Man's Non-Water Activities — Group 4C

Descriptors: \*Judicial decisions, Legal aspects, Water law, Remedies, \*Natural flow doctrine, \*Obstruction to flow, Surface runoff, Drainage, \*Illinois

Plaintiffs, alleged owners of a dominant heritage, enjoying a perpetual easement for drainage in a natural watercourse, brought suit to restrain the owners of the alleged servient estate and persons who they allowed to dump fill upon their land from further impairing the flow of surface water from plaintiff's land. The complaint alleged that the obstructions on defendants' land caused water to accumulate on plaintiff's land. A mandatory injunction was also prayed for to order defendants to remove the fill and a house and garage. At trial, the chancellor found for defendants. On appeal to the Supreme Court, affirmed. This case turned on the question of fact whether the drainage from plaintiff's land was obstructed by the fill and structures on defendant's land. Where there is conflicting evidence, and it is heard in open court, the chancel lor's ruling based thereupon will not be disturbed unless clearly against the manifest weight of the evidence. (R. F. Williams-Fla) W69-01355

## MIDGETT V NORTH CAROLINA HIGHWAY COMM'N )CONTINUING NUISANCE AS A PUBLIC TAKING(.

260 N C 241, 132 S E 2d 599-609 (1963).

Descriptors: North Carolina, Eminent domain, Civil law, Natural flow doctrine, \*Road construction, \*Effects, Riparian rights, Riparian land, Appropriation, Water pollution, Flood damage, \*Surface waters, Sea water, Atlantic Ocean. Identifiers: \*Nuisance (Legal aspects).

The construction of a highway by defendant highway commission constituted a dam which prevented ocean waters that for many years had come over dunes in time of storm from being dissipated toward sound and which caused great quantities of water to inundate the property of plaintiff. The judgement for the defendant was reversed because defendant's construction was an appropriation of land for public use. North Carolina does not apply the common enemy doctrine to surface waters, but applies the Civil or Natural Flow Doctrine. The effect of the highway was to create a private nuisance. It was a jury question as to whether or not defendant might reasonably have anticipated storm or flood. A continuing nuisance maintained by government which substantially impairs private property values is a taking in the constitutional sense. (Crabtree-Fla)

#### HEWITT V CHICAGO B ANDQ RY )OBSTRUCTION TO FLOW CAUSING FLOODING(.

426 S W 2d 27-33 (Mo 1968).

Descriptors: \*Flood damage, Floods, Obstruction to flows, Streamflow, Riparian rights, Riparian land, Levees, Water law, Legal aspects. Identifiers: Evidence.

The plaintiffs brought action for damages from flooding caused by defendants' railroad bridge which was alleged to have been constructed without suitable openings. The court held that the evidence was sufficient for the jury to find that the flood damage in 1964 was caused by the defendants' bridge. There was a lack of evidence, however, to establish that the bridge was the cause of flooding in 1960 through 1963. Where an obstruction of a watercourse causes annual or occasional flooding of lands, each repetition of overflow gives rise to a new cause of action. (Horner-Fla) W69-01366

#### TURNER V ROSS )DAMAGES FOR INCREASING FLOW OF SURFACE WATERS(.

115 Ga App 507, 154 SE 2d 798-801 (1967).

Descriptors: \*Georgia, Natural flow, Judicial decisions, Remedies, \*Surface runoff, \*Surface drainage, Riddance (Legal aspects), Drainage water.

Identifiers: \*Damages (Legal aspects), Dominant estate, Servient state, Remedies (Legal aspects).

This was a suit for damages by the owner of a servient lot against the owner of an adjoining dominant lot for maintaining an abatable nuisance. Defendants graded the dominant lot in such a way that it increased the natural flow of surface water onto plaintiff's lot, causing silting of plaintiff's lot and flooding of his basement. The main issue was the proper amount of damages. There was conflicting testimony from the plaintiff as to the amount of damage to his property, and during the course of the trial plaintiff's counsel stated that in this suit the plaintiff could not recover future and permanent damages. The court held that the plaintiff's testimony must be strictly construed against him as to the amount of damages, and that the statement of plaintiff's counsel estopped plaintiff from recovering damages for permanent dimunition in value of his property. (Kirkconnell-Fla) W69-01367

#### CENTRAL INDIANA RY V MIKESELL DAMAGES FROM EMBANKMENT COL-LAPSE(.

221 NE 2d 192-201 (111 App Ct 1966).

Descriptors: \*Storm runoff, Drainage, Tile drainage, Rainfall intensity, Storms, \*Damages, Washouts, Legal aspects, Collapse, Embankments, Probably maximum precipitation, \*Excessive precipitation, Culverts.

Identifiers: Railroad embankment, Anticipated rainfall.

A 15 foot high railroad embankment running along the back of plaintiff's residential property gave way during a heavy downpour. The railroad maintained two tiles totaling 20 feet of opening for the passage of water through the grade. The street running along the front of plaintiff's lot had a drainage pipe with a 19.5 foot opening. Defendant's argument that layer openings under the grade would have caused damage, and that water upon plaintiff's land prior to the break caused the damage, were rejected because the damage was cause by the sudden spurt of water from the break in the embankment. Even though the size of the downpour was unusual and extraordinary, there was sufficient evidence for the jury to determine that the exercise of reasonable skill and foresight should have led to its being anticipated. There was evidence that such rains occurred with a frequency of from 20 to 100 years, and that defendant's opening were insufficient. Damages of \$2,628 were allowed to compensate for the loss of plaintiff's garage, tool shed, flower garden, family snapshots, driveway and fence, and damage to the foundation and basement of the house. (McDermott-Fla)
W69-01375

## LOWE V LOGE REALTY CO )NATURAL WATERCOURSE AND DIFFUSED SURFACE WATER DISTINGUISHED(.

214 N E 2d 400-403 (Ct App Ind 1966).

Descriptors: \*Indiana, Natural streams, \*Drainage water, Surface waters, Surface runoff, Repulsion (Legal aspects), Obstruction to flow, Intermittent streams, Legal aspects, Judicial decisions, Relative rights, Alteration of flow, Riddance (Legal aspects).

Plaintiff alleged that the defendant was building roads and storm sewers which collected large quantities of rain water and snow water and discharging them on plaintiff's land. Defendant counterclaimed and alleged that there was a natural watercourse across plaintiff's land, and that any flooding of plaintiff's land was the result of obstructions placed in the watercourse by the plaintiff. The Indiana ap-

pellate court held that where surface water begins to flow in a definite direction in a regular channel with well-defined banks and bottom, and the flow is from time immemorial and for a substantial period each year, a natural watercourse exists. A landowner can prevent surface water from running on his property by erection of barriers, but where, as here, there is a natural watercourse he cannot barricade it so as to cause damage to another. The plaintiff would be entitled to relief only where the defendant by artificial means so increased the volume of flow as to damage the plaintiff, since the defendant had the right to reasonably divert the flow of surface water into a natural watercourse. (P. N. Smith-Fla) W69-01380

## GARFIELD V EAST PATTERSON )INCREASING FLOW OF SURFACE WATERS(. 47 N J 195, 219 A 2d 865 (1966).

Descriptors: \*New Jersey, \*Overland flow, \*Surface runoff, Judicial decisions, Floods, Local government, Cities, Flood damage, Watercourses (Legal), Natural streams, Surface drainage.

This was an action by a city against numerous defendants, including the State Highway Department and the New Jersey Highway Authority for periodic flooding of a natural watercourse. The city's contention was that with development of the area by defendants, water which would have found its way slowly to the watercourse was now sped on that course by paving and other improvements; and thus the propensity for flooding was intensified. Judgment was properly rendered for the several defendants where, upon the record made, a court could not possibly assess responsibility, if any, of any of the governmental defendants. (Kirkconnell-Fla)

## SHERRILL V NORTH CAROLINA STATE HIGHWAY COMMISSION ) OBSTRUCTION TO FLOW OF SURFACE WATER(. 264 N C 643, 142 S E 2d 653-657 (1965).

Descriptors: \*North Carolina, Damages, \*Culverts, Easements, Legal aspects, Eminent domain, Judicial decisions, Watercourses (Legal). Identifiers: Constitutional law.

Plaintiffs brought an action against defendant Highway Commission for damage to their property. The commission was responsible for maintenance of a culvert which allowed waters of a creek to pass under a highway and by part of the plaintiffs' property. Due to an increased volume of drainage water, heavy rains, and the fact that the angle of the culvert did not follow the natural course of the stream, the foundation of the plaintiffs' store and other property was damaged. The Supreme Court of North Carolina, overruling a lower court, held that these facts were sufficient to establish that the continued maintenance of the fill, culvert and highway constituted a permanent taking in the constitutional sense as of the time that the bank of the creek had washed away up to the plaintiffs' property. Subsequent to this time an easement to discharge water against plaintiff's property was taken, which would also require compensation. (Patterson-Fla) W69-01390

## COMMONWEALTH V THOMAS )RIPARIAN RIGHT OF ACCESS(.

427 S W 2d 213-218 (Ct App Ky 1967).

Descriptors: \*Kentucky, Legal aspects, Judicial decisions, Riparian rights, \*Eminent domain, Compensation, Riparian land, Identifiers: Right of access.

In this case landowners seek to recover for loss of access to a lake by reasons of construction of a

#### Field 04 - WATER QUANTITY MANAGEMENT AND CONTROL

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roadway and fill across an inlet of the lake bordering on the landowner's property. The court held that riparian landowners have the right of a reasonable access to the entire body of water on which their land borders. This right of access has value, and before the state can take or impair such right it must pay just compensation to the owner for it. (P. N. Smith-Fla) W69-01395

#### EFFECT OF URBAN GROWTH ON STREAM-FLOW REGIMEN OF PERMANENTE CREEK, SANTA CLARA COUNTY, CALIF, E. E. Harris, and S. E. Rantz.

U S Geol Survey-Water Supply Paper 1591-B, 1964, 18 p.

Descriptors: \*Storm runoff, \*Land use. Identifiers: \*Urban drainage, Surface permeability.

Evidence that volume of storm runoff produced by rainfall on valley floor has increased substantially as result of urbanization; increase in outflow is attributed to fact that urban development during period 1945 to 1958 increased extent of impervious surface in product area from about 4% to 19%

#### 4D. Watershed Protection

#### LEGAL ASPECTS OF THE WATERSHED PROGRAM IN IOWA, SMALL.

Iowa University, Iowa City Charles Campbell, N. William Hines, and Marshall Harris.

Monogr 6, Cool Law, Univ Ia, Sept 1965. 45 p, 1 fig, 1 map, 3 tab, 13 ref, append. OWRR Project A-

Descriptors: \*Legal aspects, \*Watersheds, \*Iowa, Hydrology, History, \*Water laws, Soil erosion, Soil conservation, Flood control, \*Small watersheds. Local governments.

The monograph covers the historical aspects, Federal and Iowan of watershed protection and flood control laws, discusses the operation of the Small Watershed Program in Iowa, local sponsor ing organizations, and makes recommendations as to the utilization of various local sponsoring organizations. It is meant to create awareness and provide sufficient detail concerning operation of the Small Watershed Program for rural and urban lowans, lowa attorneys, and others who guide community decisions. W69-01255

#### JOHNSTON V STAPLES )CREATION OF WATERSHED DISTRICT(. 408 S W 2d 206-207 (Ky ct app 1966).

Descriptors: \*Kentucky, Water conservation, Remedies, Judicial decisions, Federal government, Legal aspects, Taxes, \*Watershed management, Water districts

Identifiers: Conservation districts.

In an action challenging the validity of a watershed conservancy district's creation and to prevent making of an exploratory survey to determine feasibility of creating such a district, summary judgment was granted for defendant. Appellants are seeking to test the correctness of the trial court's refusal to accept their amended complaint alleging that much of the land within the district belonged to the U S government and was not subject to taxation as required by the statute creating conservancy districts. This court found that while the statute does provide that all property within a district shall be taxed the statute should be read to carry out legislative intent. The intent was only to tax property subject to tax. In any event the US government had not complained of the inclusion of its land within the district and appellants could not do so. The trial court did not abuse its discretion in refusing the amended complaint. (Kahle-Fla) W69-01313

#### INTERSTATE WATERSHED COOPERATION ACT.

Arkansas Laws Act 31 (1967).

Descriptors: \*Arkansas, Legislation, Water districts, \*Watershed management, Water management (Applied), \*Water resources development, Local governments, Assessments, Administrative \*Cooperatives, \*Interstate compacts, agencies. Project planning.

This act was passed to give local improvement districts the power to participate in interstate watershed projects. It enables the districts to take advantage of federal assistance in this area. The act authorizes the governing authority in each improvement district to enter into agreements with other improvement districts both in Arkansas and in adjoining states, for the purpose of planning, constructing operating and maintaining improve ments in interstate watershed projects. The districts are also given the power to levy taxes to fulfill that district's obligations in any such agreements into which it might enter. (Sisserson-Fla)

#### COSTLEY V LONG )DAMAGES FOR DIVER-SION OF STREAM(.

112 Ga App 758, 146 S E 2d 153-155 (1965).

Descriptors: \*Georgia, Legal aspects, Judicial decisions, \*Alteration of flow, Streamflow, Diversion, Streams, Erosion, Stream erosion, Relative rights, Flood damage, Water injury.

This is an action between adjoining landowners in which the plaintiff sought to recover damages for diversion of a stream on defendant's land which caused water to stand on plaintiff's land and which caused erosion of his land. The Georgia Court of Appeals held that a landowner can change the course of a stream running through his property, provided that he return it to its original channel be fore it leaves his property and so long as the change does not injure or unduly interfere with any other landowner. When this change of course results in flooding and erosion of plaintiff's land, he may recover for the diminution of fair market value of his land caused by the defendant's actions. (P. N. W69-01381

#### EVALUATION OF MULCHES FOR WATER-

EVALUATION OF MODERIES FOR STATES OF THE RESIDENCE OF THE 440, 1965. 3 p, 5 tab.

Descriptors: Arid climates, Stubble mulching, \*Mulching, Organic matter, Water conservation, \*Erosion control, \*Rainfall intensity, Hay, Rates of application, Asphalt, Runoff. Identifiers: Plots, Straw.

Objectives of a water erosion study conducted at Lincoln, Nebraska, were: (a) to compare the relative effectiveness of prairie hay, wheat straw, woodchips, and an asphalt emusion in protecting a soil surface against water erosion and (b) to determine the most effective method of anchoring organic materials for stabilizing soil surfaces against water erosion. Three high rainfall intensities were used to check the effect of runoff and sediment load from the plots. A 1/2-ton-acre prairie hay mulch anchored by an asphalt emulsion applied at I quart per square yard provided the best protection against water erosion. Prairie hay and wheat were comparable in their effectiveness as mulches for protection against water erosion and were more effective than woodchips. Equal amounts of prairie hay mulch applied as a loose mulch or anchored with a disk packer were not significantly different in amount of protection pro vided against water erosion. Materials and methods used in the study could be applied to arid climates where high rainfall intensities cause water-erosion control problems. (Blecker-Ariz) W69-01474

#### CONSERVATION BENCH TERRACES IN TEX-

Agricultural Research Service, Bushland, Texas. For primary bibliographic entry see Field 03F. For abstract, see . W69-01493

#### 05. WATER QUALITY MANAGEMENT AND PROTECTION

#### 5A. Identification **OF Pollutants**

#### EVALUATION OF AN INDEX FOR VIRAL POL-

LUTION, Kansas Water Resources Research Institute, Lawrence

Lawrence.
Raymond C. Loehr, and Diann T. Schwegler.
OWRR Research Report A-001-KAN, University
of Kansas, Lawrence, pp 1-59, May 1965-June
1966. 59 p, 16 fig, 13 tab, 36 ref.

Descriptors: \*Viruses, Water pollution, Waste water. Water treatment. \*Water quality. pH. \*Sampling, Bacteria, Epidemics, Bacteriophage, Detection, Potable water, Bibliographies, \*Evaluation, Waste treatment, Waste water treatment. Identifiers: Water biology.

Current viral detection techniques rarely are used routinely by health agencies or water treatment personnel to monitor potable and waste water because of the equipment and experience necessary. This report explores the use of coliphage, viruses of coliform bacteria, as a measure of the virological quality of water. Some results of this research are: (1) For routine sampling of water and waste water, the soft agar technique is more precise and less likely to be affected by contaminants than is the filtration method. (2) There is no need for sample preparation prior to detection of the phage except to inhibit phage reproduction between sampling and analysis. (3) The average coliphage concentration in waste water was about 1000 phage/ml. The range of collected data was from 25 to 22,000 phage/ml. (4) The analysis of coliform phage in water and waste water continues to show promise as a routine technique to monitor the virological quality of such waters. (Hess-Kansas) W69-01232

#### BIOLOGICAL FIELD INVESTIGATIVE DATA FOR WATER POLLUTION SURVEYS.

Federal Water Pollution Control Administration, Washington, D. C.

William M. Ingram, Kenneth M. Mackenthun, and Alfred F Bartsch

Fed Water Pollut Contr Admin Publ WP-13, 1966. 139 p, 51 fig, 5 tab, 467 ref. FWPCA Grant WP-00013.

Descriptors: Biology, \*Water pollution, Bioassay, Aquatic life, On-site investigations, \*Pollutant identification, Aquatic environment, \*Investigations, Bibliographies, \*Reviews.

A compilation such as this was first envisioned by the senior author in 1950 during the early years of the national water pollution control program. Over the past 15 years there has been a great demand for biological information as related to water pollution prevention and abatement programs, indicating a need to publish under one cover the natural history aspects of water pollution investigations. Today there are many professions working in water pollu-tion control. All of them can well utilize some basic knowledge of the ecological environment. This book will serve to introduce the non-biologist to the life sciences as they relate to water pollution and its control. The professional biologist, inexperienced in water pollution investigations, will find the book a quick introduction to field studies of polluted streams, lakes and artificial impoundments. For the professional investigator, sources of

#### Sources of Pollution - Group 5B

further information, both general and detailed, are set forth in the selected references and bibliography to help in his field studies - an underlying feature of the national effort to conserve and protect our water resources. (Author) W69-01246

#### ANALYSIS OF NATURAL RADIOELEMENTS IN RAW WATER,

Rhode Island University, Kingston.

Vincent C. Rose.
Final Rep, Water Resour Res Proj A-011-RI, Washington, D. C., June 1967. 5 p, 1 ref.

Descriptors: Water, Ion exchange, Gamma rays, Spectrometers, \*Water pollution, Analysis, \*Radioisotopes, X-ray analysis, Resins.

Experimental ion exchanger loaded filter papers have been prepared to remove natural radioelements from water. In preliminary studies a mixture of 40% Permutit Q, 30% cellulose and 30% fiber glass gave optimum flow rates for the total removal of potassium. The optimum resin size was 80-100 mesh. In later studies the fiber glass was eliminated to permit x-ray analysis of other trace metals. After studying composition, flow rates, number of passes through the filter and percent removal, a composi-tion of 45% resin (50-100 mesh) was selected. A combination of two papers and multiple recycle was necessary to make the results independent of flow rates. Five millileter plastic columns containing Permutit Q were prepared to fit in the 5/8 inch well of a NaI crystal. Loading curves were determined for K, Rb, Th and U. Low sample to background rates precluded the use of gamma spectrometry for the analyses of K. and Rb. As little as 0.5 mg of Th and U were detectable with a 40 minute counting time. (Author) W69-01256

#### AMENDMENT TO THE SANITARY WATER BOARD ACT OF 1951. State of Illinois, Springfield

Illinois Laws ch H 1921 (1967).

Descriptors: \*Administrative agencies, \*Illinois, Descriptors: "Administrative agencies, "Illinois, Legislation, Administration, Planning, State governments, Programs, "Water pollution control, Water quality, Waste water (Pollution), Standards, Legal aspects, Water law, Water policy, Financing, Government finance, Sewage treatment, Water pollution treatment, Project planning, Pollutant identification. identification.

Section six of the Illinois 'Sanitary Water Board Act' of 1951 is amended by this act. The power of the Sanitary Water Board is extended so that the Board may determine if pollution exists in any of the state's waters, and make orders requiring the discontinuance of pollution activities. The Board is specifically authorized to make findings of fact with respect to violations of the Act, or of the Board's orders; to institute legal proceedings to compel compliance with th Act; to issue or deny permits for the discharge of sewage; and to promulgate standards of quality for the state's waters. Among the duties assigned to the Board are the following: To prepare a comprehensive plan for abatement of present and future pollution, to scrutinize all plans for sewage works and to inspect their construction, and to serve as the state's agency for the receipt of federal funds for pollution abatement. The Board is given the right to enter private property in order to inspect conditions relating to pollution, and to require submission to it of any relevant records or reports. (Pfeiffer-Fla) W69-01309

## A PROBABILISTIC METHOD OF APPRAISING BIOASSAY SAMPLING PROGRAMS, E I duPont de Nemours And Co, Savannah River

Lab, Aiken, SC.

F. Delano Knight, and S. Marshall Sanders, Jr. Health Phys, Vol 14, No 5, pp 523-524, May 1968. 2 p, 1 fig, 2 ref.

Descriptors: \*Path of pollutants, Radioisotopes, Water pollution effects, Water pollution sources, Radioecology, Public health, Radioactivity, Hazards, Probability sampling. Identifiers: Health physics, Plutonium, Maximum permissible body burden.

A new criterion, developed to appraise coverage of health physics sampling programs of periodic urinalysis, can now be expressed in terms of the probability, P, of detecting an assimilation of D% of maximum permissible body burden in a group of individuals where the fraction of the group, F, is sampled every I days. That probability is defined by the relationship, P = 1 - (1-F) to the mth power (1-F (n-m)), where n is the ratio of T/I and m is the number of whole integers in that ratio. Values of T, the length of time when the rate of excretion is above the limit of detection, can be computed from an exponential expression relating E, the quantity of radionuclide excreted per day T days after assimilation, to D and T. That calculation for plutonium takes the form, T=(2.0424D/E) to the 1.3 power. W69-01425

#### 5B. Sources of Pollution

#### BAND DIFFUSION WITH VARIABLE PARAME-TERS ALONG FLOW, Syracuse University, New York

For primary bibliographic entry see Field 02F. For abstract, see. W69-01238

#### WATER POLLUTION - NATURE, EFFECTS, TREATMENT, ALTERNATIVES TO TREAT-MENT.

pp 5-17 of Entry No. W69-01269 in 05G.

Descriptors: Biochemical oxygen demand, Chemical wastes, Decomposing organic matter, Domestic wastes, Farm wastes, Industrial wastes, Organic wastes, Oxygen sag, Nitrification, \*Pollutant identification, Pollutants, Radiological wastes, \*Water pollution, \*Water pollution effects, Water pollution sources, \*Water pollution treatment, Pollution abatement, Water treatment, Sediments, Public rights.

A summary of the physical aspects of water pollution and the technical devices available for its abatement is presented. Various classification systems are discussed, but it is concluded that these tend to obscure the complex phenomena that occur in a stream. The primary effects of water pollution are discussed. These are recreational and aesthetic effects, effects on domestic supplies, effects on industrial supplies and the establishment of a technical link between economic units. Methods of treatment are discussed with emphasis on the broad range of alternatives available. It is concluded that value considerations must be introduced into the decision making process and that public intervention is justified. (Pfeiffer-Fla) W69-01270

## RESSLER V GERLACH )NEGLIGENT WELL CONTAMINATION(. State of Pennsylvania, Harrisburg. For primary bibliographic entry see Field 02F.

For abstract, see .

#### DISPOSAL OF GARBAGE AND REFUSE ON HIGHWAYS, PRIVATE PROPERTY, OR IN COASTAL OR INLAND WATERS; PENALTY. State of Massachusetts, Boston

Mass Ann Laws Ch 270, Sec 16 (1967).

\*Massachusetts, Legislation, \*Domestic wastes, \*Inland waterways, \*Coasts. Identifiers: Crimes.

Whoever disposes of any rubbish in coastal or inland waters, salt or fresh, or within twenty yards of such waters shall be punished by a fine of not more than \$50. If a motor vehicle is used, the registrar of motor vehicles may suspend the violator's drivers license for not more than 30 days. If the violator is the owner of the car which was used, his certificate of registration may be suspended for not more than 30 days. (Williams-Fla) W69-01289

#### PHOSPHORUS CONTENTS OF SEWAGE-POL-LUTED WATERS,

Indian Inst of Science, Bangalore, India. E. G. Srinath, S. Sathyanarayana Rao, and S. C. Pillai.

Indian J Exp Biol, Vol 4, No 2, pp 114-119, 1966. 6 p, 9 tab, 42 ref.

Descriptors: \*Eutrophication, \*Water pollution sources, Nutrients, Phosphates, Activated sludge, Sewage, Protozoa, Aeration, Ponds, Rivers. Identifiers: India, Epistylus.

Soluble phosphates in relatively high concentrations characterize sewage-polluted waters. Values for phosphorus concentrations in some polluted water from Indian rivers and ponds range from 1.7 to 3.1 mg/1, of which 71-90% is in soluble form. When sewage samples are diluted with tap water in different proportions and these samples are allowed to stand or are artificially aerated for 15 days, amounts of soluble phosphate in the supernatant liquids are not appreciably altered. Activated sludge with associated protozoa (principally Epistylus) removed about 85% phosphorus from supernates of undiluted sewage after 6-hr aeration, but only about 26% from diluted sewage samples. The reduced removal of phosphate in diluted samples is attributed to lack of other necessary nutrients. To eliminate 2.7 mg/1 of phosphate from effluent of activated sludge process, the following concentrations of chemical coagulants (in mg/1) were found to be required: alum only, 5; lime only, 5; ferric chloride only, 6; alum and lime, 2 each; alum and ferric chloride, 2 and 3 respectively; and lime and ferric chloride, 2 and 3 respectively. Waters unpolluted with sewage may also contain phosphate, depending on the nature and extent of their contamination with other forms of organic matter W69-01427

#### MAJOR SOURCES OF NUTRIENTS FOR ALGAL GROWTH IN WESTERN LAKE ERIE, Federal Water Pollution Control Admin., Grosse

Ile, Mich. George L. Harlow.

Publication Number 15, Great Lakes Res Div, Univ Mich, pp 389-394, 1966. 6 p, 2 fig, 5 tab, 9 ref.

Descriptors: \*Eutrophication, \*Lake Erie, \*Nutrients, Algae, Water pollution sources, Nitrogen compounds, Phosphates, Great Lakes,

Identifiers: Lake St Clair, Rouge River, Huron River, Raisin River, Detroit River, Maumee River.

Due to an excess of nutrients, western Lake Erie has developed prolific blooms of algae contributing to and indicating the accelerated enrichment of this valuable natural resource. Nutrient concentrations and quantities increase as the waters from Lake St Clair pass by the metropolitan complex of Detroit to western Lake Erie. The sources of waste which contribute to these increases are presented, as well as the relative quantities from each waste source. Municipal wastes contribute 89% of phosphates and 86% of total nitrogen received into Lake Erie from southeast Michigan, whereas the contribution of phosphate from land drainage is a minor factor. Nitrogen runoff from lands contributes more significantly to nutrient loading than does phosphate from the same source. In Lake Erie, concentrations of nutrient compounds closer to the mouth of the Detroit River are higher than at stations further offshore, except in the case of two

#### Field 05-WATER QUALITY MANAGEMENT AND PROTECTION

#### Group 5B-Sources of Pollution

offshore stations thought to be influenced by the Maumee River. Results of nutrient determinations from all stations reported for Lake Erie show concentrations greater than those thought to be critical for triggering blooms of algae. W69-01445

#### SOURCES OF NITROGEN AND PHOSPHORUS IN WATER SUPPLIES. TASK GROUP REPORT.

J Am Wat Wks Ass, Vol 59, pp 344-366, 1967.

Descriptors: Runoff, \*Nutrients, Nitrogen, Phosphorus, \*Water supply. Identifiers: \*Urban drainage.

In this second part of Task Group 2610P of the American Water Works Association, the sources from which nitrogen and phosphorus may enter water supplies are reviewed; a bibliography of 63 references is appended. Sources of these nutrients include sewage, synthetic detergents, industrial wastes, compounds used in water treatment, runoff from agricultural and urban areas, wastes from farm animals and wildfowl, rainfall and dustfall, and nitrogen fixation. Some figures showing increases in nutrient content of various rivers and lakes in U.S. are quoted. From the available data, an attempt has been made to estimate the relative significance of the various sources of nitrogen and phosphorus, and the results are tabulated, showing that agricultural run-off is the greatest single contributor of nitrogen and phosphorus to water supplies. The possibility of controlling the amounts of nutrients contributed by various sources is considered briefly. W69-01497

#### POLLUTION OF THE RIVER MERSEY.

Effluent and Water Treatment J, Vol 3, pp 217-22, April 1963.

Descriptors: \*Storm runoff, \*Overflow, Cities, \*Water pollution, Bioindicators. Identifiers: \*Combined sewers, \*River Mersey, Great Britain.

The chief source of pollution in the River Mersey is from large discharges of trade effluents. The discharge of such wastes into public sewage treatment works would improve the condition of the river substantially. The desirability of treating trade wastes in sewage treatment plants indicates the advantage of centralization of sewage disposal works. Another major source of pollution in urban areas is the premature operation of storm sewage overflows. This frequently happens in dry weather when streams are at low flow. The Mersey River Board has recommended that, where practicable, the overflows would not operate until at least 8 times dry weather flow has been reached. The significance of pollution is evidenced by typhoid, paratyphoid, and Salmonella infections directly from polluted water or indirectly from food contaminated by it. W69-01501

SECOND QUINQUENNIAL ABSTRACT OF STATISTICS RELATING TO RIVER SURVEYS IN THE TRENT WATERSHED COVERING THE FIVE-YEAR PERIOD 1957 TO 1961 )WITH SOME SUPPL DATA FOR 1962(. Trent River Board.

120 p, map.

Descriptors: \*Storm runoff, \*Water pollution, Sewers, Overflow. Identifiers: \*Urban drainage.

Data are tabulated from chemical and biological surveys of rivers in the Trent watershed in the period 1957-1962, and the percentage change in composition between 1951 and 1962 is estimated for various sampling points. The condition of the

various stretches of watercourses is indicated on a map using a colour-coding scheme. At present, about 80 per cent of the streams in the watershed are reasonably clean and of some use to the community, but there are still about 150 miles of watercourse which are badly polluted. Only 60 per cent of the sewage effluents reach the requirements set by the River Board but the treatment facilities are being improved gradually. Factors contributing to the deterioration of surface waters are discussed, including the delay in constructing water-treatment facilities for new housing and industrial developments, increasing volumes of effluent and increasing abstractions of water (which increase the ratio of used matural water in the streams), and increasing volumes of storm run-off for which there is insufficient sewer capacity, especially in older urban sewerage systems which do not provide capacity for six or even three times dry-weather flow. Where it is not practicable to improve conditions in streams by imposing higher standards for effluents and discharges from storm-sewage overflows, it may be necessary to consider 'farming the river' to ensure the greatest possible degree of self-purifica-W69-01511

ANNUAL REPORTS OF THE SEVERN RIVER BOARD AND THE WYE RIVER BOARD FOR THE YEAR ENDED 31ST MARCH, 1964. Severn River Board; Wye River Board.

77 and 60 pp respectively.

Descriptors: \*Water pollution, \*Storm runoff, \*Standards, Biochemical oxygen demand, Discharge (Water), Estuaries. Identifiers: \*Suspended solids, Great Britain.

Both these reports contain sections on water resources, fisheries and prevention of pollution. Hydrological surveys are reported for parts of the catchments of the rivers Bewdley and Avon. Abstraction of water irrigation is increasing and the importance of providing bank storage has been emphasized. Results of surveys of the rivers Severn and Avon, certain of their tributaries, and tidal waters are given and discussed in detail in relation to the various sources of pollution and prospects for future improvements. It is planned to make a complete survey of the rivers Wye and Lugg each month, with less frequent sampling of other tributaries, and the first two complete surveys are reported and discussed. It is considered that effluents discharged to the Wye estuary should conform to the normal standards for a grade-one effluent, in view of the character of the river and the mortality of salmon in the tidal reaches nearly every summer. A measure of control has also been extended to estuaries in the Severn River Board area, and an appreciable departure from the normal working standards was possible when determining the required standards for partially-treated sewage and sewage-works effluents. Basic standards for the discharge of effluents to watercourses are also outlined, including those for pre-1951 discharges. In the case of farm waste waters, allowance is made for the self-purification which may take place in the ditch or stream to which the effluent is discharged. With regard to partially-treated storm sewage, the Severn River Board have abandoned the standard limiting the BOD and, apart from specific standards for toxic materials, the strength and quality of these discharges are now controlled by a limit of 100 p.p.m. on the concentration of suspended solids. This standard also applies in the Wye River Board area where the concentration of sulphide is also limited to 1 p.p.m., as hydrogen sulphide. The standard imposed on the discharge of chlorinated water from a swimming pool limited the concentration of chlorine to 0.5 p.p.m., as free chlorine, and also limited the rate of discharge to ensure that there was sufficient dilution available in the receiving stream to avoid the risk of toxicity to fish. Alterations in the treatment and discharge of sewage and trade waste waters are outlined, together with proposals for new treatment plants. W69-01520

DELWARE ESTUARY COMPREHENSIVE STUDY PRELIMINARY REPORT AND FINDINGS.

Federal Water Pollution Control Admin., Phila., Pa.

For primary bibliographic entry see Field 02L. For abstract, see . W69-01522

#### 5C. Effects of Pollution

EFFECTS OF WASTES ON RECEIVING WATER--SOME COMPUTATIONAL AND SCIENTIFIC PROBLEMS.

pp 49-56 of Entry No. W69-01269 in 05G.

Descriptors: Biochemical oxygen demand, Algal toxins, Organic wastes, Pollutant identification, Pollutants, Quality control, Water pollution, \*Water pollution sources, Separation techniques, \*Analytical techniques, Classification, \*Model studies, Waste identification, Biological properties, Physical properties, Waste water (Pollution), Water quality, Water pollution effects, Impaired water quality, Wastes.

Computational and scientific problems involved in determining the effect of wastes on receiving water are discussed. The need for an efficient and flexible means of calculation of pollutants is noted and problems involved in devising such a means are discussed. Two basic problems are presented. The first is the conceptual problem of devising a model which comprehends relevant relationships and is amendable to rapid calculation. The second is the determination of the specific numerical effect of a change in one variable on the others. It is con-cluded that accurate knowledge of physical and biological relationships in water bodies is an essential prerequisite to the design and operation of optimum waste-disposal systems. Research geared to exploring a more definitely empirical approach to water phenomena is encouraged. W69-01273

LIABILITY OF PERSON OBSTRUCTING STREAM, RAVINE, OR SIMILAR AREA BY DEBRIS OR WASTE, FOR DAMAGES CAUSED BY FLOODING OR THE LIKE,

L. S. Tellier. 29 ALR 2d 447-467, 20 p, 103 ref.

Descriptors: \*Streams, \*Natural streams, \*Obstruction to flow, Bridges, Culverts, Floods, Flooding, Conduits, Bottom sediments, Waste disposal, Riparian rights, Riparian lands, Flood damage, Remedies, Watercourses (Legal), Water laws, Legal aspects.

Generally, the person considered responsible for the obstruction of a natural stream by debris or waste is liable for damages to property resulting from the obstruction. The annotation discusses the limitations and variances of this general rule and its application to specific types of situations. The discussion is limited to the obstruction of natural streams but includes situations where the natural streams passes through a culvert or under a bridge. The specific situations considered are where a dam is caused by debris, where culverts and bridges have become clogged, where the bed of a stream is filled by wastes, and where waste is discharged into a stream. (Horner-Fla) W69-01293

MEASURE OF DAMAGES FOR POLLUTION OF WELL, CISTERN, OR SPRING, F. G. Madara. 19 ALR 2d 769-783.

Descriptors: \*Water pollution, Damages, Legal aspects, Cisterns, \*Wells, \*Springs, Measurement. Identifiers: Permanent damage, Temporary damage.

The general measure of damages for permanent injury by pollution of a well, spring, or cistern is the difference between the market value of the land before injury and after it. An alternative measure sometimes used is the cost of supplying the injured plaintiff with water of equally pure quality of that which he had. Injury which would last for an in-definite period of time could be treated as a permanent injury. For a temporary injury, one that is abatable, the plaintiff is usually allowed that amount which would compensate him for diminution or loss in the value of the use of the well, spring, or cistern during the time the pollution continued, limited in some jurisdictions to the time of the commencement of action and in others to the time of the trial. An alternate method allows the plaintiff to recover the depreciation in rental value of the property while the pollution lasts. If the plaintiff could have removed the cause of the pollution, his damages would only run up to the time when he could have ended the pollution. Special and consequential damages may be recovered as long as they arise directly and proximately from the pollution. Punitive damages have been allowed. The landowner could also recover expenses occasioned as a result of the pollution, such as purifying a well or getting a new one. (Sisserson-Fla) W69-01297

#### MEASURE AND ELEMENTS OF DAMAGES FOR POLLUTION OF A STREAM, W. R. Habeeb 49 ALR 2d 253-314

\*Judicial decisions, \*Damages. Descriptors: \*Water pollution, Reasonable use, Value, Market value, Depreciation, Economic rent, Water utilization, Odor, Trees, Crops, Recreation, Boating, Swimming, Fish, Livestock

Elements to be considered when measuring damages for stream pollution are examined. Where permanent or irreparable damage results, recovery may be had for the depreciation of market value of the property. However, where the damage can be remedied at a cost lower than the loss in market value, the cost of such repair becomes the measure of damages. Where the pollution is temporary or abateable, the measure is the depreciation in the rental or usable value of the property. Special damages may also be recovered, as may punitive damages, depending upon the particular circumstances. Particular items of damages such as impairment of use and enjoyment of property, noxious odors, discomfort and inconvenience, sickness, trees, crops, deprivation of use of water, recreation privileges, fish, death and injury of livestock, injury to business, expense of repairing injury, fencing, procuring water, expense of mill operations, and others are also examined. (S. Scott-

W69-01338

#### THE RELATION OF WATER QUALITY TO WATER USERS,

Resources for the Future, Inc. Allen V. Kneese, and Blair T. Bower. In Managing Water Quality, Baltimore: Johns Hop-kins Press, 1968, Chap 3, p 31-41, 1 fig, 10 ref.

Descriptors: \*Water quality, Domestic water, Water quality control, Non-structural alternatives, Water use, Irrigation water, Industrial water, Aesthetics, Recreation, Aquatic environment, Water treatment, \*Water pollution effects.

Determining the effects of various levels and time patterns of water quality on different uses is a critical component of water quality management. With increasing population and rising production of goods and services, there is a concomitant increase in the production and discharge of water that have impacts on the quality of receiving waters. Even under natural conditions water may require modification for certain uses. Water quality necessary for aesthetic and recreational uses is defined. The effects of discharges of various substances on aquatic

life have been the subject of many investigations with a wide variation in results. The factors that contribute to this are discussed. The amount and character of water treatment before domestic water use are related to the quality of water intake. Various aspects of this problem are briefly reviewed. Delineating the effects of the quality of water used for irrigation is more complex. Although water quality deterioration is reflected in crop yields, the extent to which crop yields are reduced is a function of a host of interrelated factors. The range of water qualities utilized in industrial operations is wide, depending in part on whether the water is to be used for processing, cooling, or sanitary purposes. These uses are discussed and some possible economical procedures put forth. (Gargola-Chicago) W69-01400

#### PRODUCTION RATE, POPULATION DENSITY, AND DRIFT OF A STREAM INVERTEBRATE, Minnesota Univ., St. Paul.

Thomas F. Waters.

Ecol, Vol 47, No 4, pp 595-604, Summer 1966. 10 p, 6 fig, 3 tab, 32 ref.

Descriptors: \*Aquatic productivity, \*Indicator organisms, \*Productivity, \*Mayflies, \*Drifting (Aquatic), Streams, Invertebrates, Minnesota, Carrying capacity.

Identifiers: Baetis, Gammarus,

Production rates of stream mayfly, Baetis vagans, estimated by two different methods (growth method and drift method), were compared and related to population density and drift rate. Greater confidence is placed in estimate of productivity from growth. In the year of study, this mayfly had two summer generations and one winter generation (mean annual population density, 1.3 g/sq m). The two production rate methods yielded estimates of 9.1 and 12.6 g/sq m/year as the sum of the three generations; both estimates were minimal. Production rates for summer generations were higher than for winter generation, although winter production was still at a significant level. A linear relationship between drift and production was not demonstrable. Summer generations drifted in large quantities, up to about 22 g/day, but winter generation appeared to drift little, if any, until near the end of the generation in early spring. Ratio of annual production rate to mean population density, or turnover ratio, was 9.7, or 3.2 times the number of generations. Biomass of Gammarus in stream studied was 10-100 times greater than that of Baetis. Author includes compilation of turnover rates reported in the literature and discusses factors which influence them. W69-01430

#### HEAT DISSIPATION AND INDUCED CIRCULA-TIONS FROM CONDENSER COOLING WATER DISCHARGES INTO LAKE MONONA.

Wisconsin Univ., Madison. Dept of Civil Engineering.
John A. Hoopes, Robert W. Zeller, and Gerard A.

Rohlich.

February 1968, 213 p, Grant 133-5371, Engineering Experiment Station - 35.

Descriptors: \*Thermal power plants, \*Thermal pollution, Heat budget, Water pollution sources, Water pollution, Lakes, Wisconsin, Currents (Water), Winds, Meteorology, Mixing, Mathematical models, Thermal radiation, Jets, Circulation. Identifiers: Lake Monona.

On Lake Monona, Wisconsin, two conduits supply cooling water to a steam-generating power plant (190 megawatts) and return heated water to the lake at a maximal rate approximating 243 cfs. At shoreline, outfalls discharge horizontally at temperatures 10 deg C greater than those of the lake. A floating baffle limits the extent of open water during winter months. Mechanisms of heat dissipation and velocity patterns resulting from heated discharges were studied by undertaking field surveys of temperature and velocity distributions in the lake seasonally and by developing mathematical models for prediction of observed temperature and circulation patterns. During non-winter months, warm water spreads as a two-dimensional jet in a surface layer about 3 ft thick. Steady-state, integral mass, momentum, and energy conservation relationships were used to describe mixing and resulting heat dissipation within the lake. Entrainment coefficients and rates of spread of jets depended on current-velocity and assumed values 2-10 times higher than those for quiescent fluid. In winter, mixing inside baffle and thermal transfer across open water surface cooled discharged water to approximately 4 deg C. Surface heat loss, calculated from radiation and temperature measurements, constituted 5-10% of total power plant heat W69-01448

#### CLEAN UP OF LAKE MICHIGAN.

Effluent Water Treat J, Vol 8, No 5, p 255, May

Descriptors: \*Water pollution control. Identifiers: \*Combined sewers, \*Lake Michigan, Storm sewers, \*Sewer separation, \*Urban drainage.

Pollution control authorities in the four states bordering Lake Michigan and the Federal Government have signed an agreement with broad powers to correct pollution in that lake. According to this agreement, storm and sanitary sewers are to be separated in new developments and in connection with urban reconstruction projects, unless pollution can be controlled by other techniques. Pollution from existing combination storm and sanitary sewers is to be controlled by July 1977 by separation of sewage before it reaches the waterways W69-01500

#### 5D. Waste Treatment **Processes**

#### THE OPTIMUM ALLOCATION OF STREAM

DISSOLVED OXYGEN,
Johns Hopkins Univ., Baltimore, Md.; Cornell
Univ., Ithaca, N. Y.

For primary bibliographic entry see Field 06A. For abstract, see . W69-01217

WATER CONSERVATION IN **FOOD** PROCESSING PLANTS,

Maine University, Orono.

Matthew E. Highlands, John M. Hogan, and Sadik

Rep, Proj No R 1084-9, Univ Maine, July 1966. 9 3 fig, 4 tab, 7 ref, append. OWRR Project A-008-

Descriptors: Water conservation, Water reuse, Potatoes, Water quality, Water requirements, Industrial wastes, Planning, Economics, Economic efficiency, Industrial plants.

A study of water conservation and reuse in potato processing plants indicated approximately 18.8% of total water intake per day could be reused with little or no further treatment. An additional 14.6% of total daily water used could be reused if suspended solids were removed and treatment to reduce microbiological populations was applied. The foregoing applies to a specific plant. Because variations in plant methods, individual of wide plants should be surveyed before recommending water reuse. W69-01265

DEFICIENCIES IN TECHNICAL KNOWLEDGE-DAMAGES, **ECONOMIC** TREATMENT, AND ABATEMENT COSTS. pp 57-85 of Entry No. W69-01269 in 05G.

#### Field 05-WATER QUALITY MANAGEMENT AND PROTECTION

#### Group 5D-Waste Treatment Processes

Descriptors: Municipal water, Public health, Water pollution, \*Water pollution effects, Water quality control, Sewage treatment, Tertiary treatment, Waste water treatment, Water pollution control, Oxidation lagoons, \*Water pollution treatment, Commercial fishing, Economics, Cost analysis, Costs, Economic impact, Recreation, Public benefits, Welfare (Economics), Social aspects.

Some of the more significant aspects of the costs of water pollution and the assignment of water quality constraints where costs cannot be satisfactorily specified are discussed. It is concluded that even though ideal accuracy and certainty of water pollution costs may be unattainable, there has been comparatively little rigorous analysis of costs from the point of view of designing efficient water pollution control systems. Alternative water quality control measures discussed include orthodox sewage treatment plants, stabilization ponds, harvested ponds, and tertiary treatment, alterations of streamflow characteristics and direct recirculation. Determinable costs discussed include the treatment costs for municipal water supplies, damages to commercial fishing, and agricultural costs. Less determinable costs include aesthetical and recreational damages and damages to public health. W69-01274

AN ACT TO PROTECT THE PUBLIC HEALTH AND TO CONSERVE AND PROTECT THE WATER RESOURCES OF THE STATE. State of Indiana, Indianapolis.

Indiana Laws Ch 263 (1967).

Descriptors: \*Legislation, \*Indiana, Sewage treatment, \*Administrative agencies, Regulation, \*Waste water treatment, Management, Classification, Evaluation, Public health, Sanitary engineer-

Enforcement of this act is placed in the State Board of Health. It provides for classification of all waste water treatment plants. The act requires the examination and certification of all operators of waste water treatment plants as to their competency to supervise the operation of the type of operated. The act prescribes the powers and duties of the State Health Commissioner and provides for the promulgation of rules and regulations by the commissioner, with the consent of the State Board of Health, to effect the objectives of the act. Any person, firm, or corporation, both municipal and private, violating any provisions of the act or the rules and regulations adopted is guilty of a misdemeanor and is subject to a maximum fine of \$500 for each day of operation in violation of the act or the rules and regulations adopted thereunder. (Watson-Fla) W69-01305

AN ACT TO AMEND SECS 6111.01, 6111.03, AND 6111.31 OF THE REVISED CODE TO EXTEND TAX EXEMPTIONS FOR INDUSTRIAL WATER POLLUTION CONTROL FACILITIES. State of Ohio, Columbus.

Ohio Laws ch S 20 (1967).

Descriptors: \*Ohio, \*Legislation, Pollution, Sewerage, \*Treatment facilities, Waste disposal, Grants, \*Taxes, Pumping plants, Pipes, Incinera-tion, Permits, Watercourses, Industrial wastes.

Terms defined are: pollution; sewage; industrial waste; other wastes, sewage system; treatment works; disposal system; waters of the state; and industrial water pollution control facility. The powers of the Water Pollution Control Board include developing water pollution control programs; administering grants; working with other agencies to accomplish pollution control; promoting studies relating to pollution; disseminating information; controlling procedures of the Board; issuring orders after public hearings prohibiting discharge of sewage or other wastes into waters of the state or requiring construction or modification of disposal

systems; issuing or revoking permits for wastes discharge or for the operation of disposal systems; instituting proceedings compelling compliance with its orders; controlling industrial water pollution control certificates; certifying to the United States that an industrial water pollution control facility conforms with requirements when required by the Internal Revenue Code; and exercising all incidental powers. The Act provides procedures by which an industrial water pollution control facility may be excepted from personal property taxes, franchise taxes and sales and use taxes. Sections 6111.01, 6111.03, and 6111.31 are amended by this Act. (Childs-Fla)

DEPARTMENT OF HEALTH V PASSAIC VAL-LEY SEWERAGE COMM'N )DAMAGE BY DIF-FUSED SURFACE WATERS(.

242 A 2d 675-684 (Super Ct N J 1968)

Descriptors: \*Sewage districts, \*Water pollution control, \*Sewage effluents, \*State jurisdiction, Administrative decisions, Water quality control, New Jersey, Judicial decisions, Treatment facilities, Water pollution treatment, Sewage treatment, Sewage disposal, Chlorination, Public health.

This action was on an order to show cause why defendant should not be directed to comply with orders of the Department of Health to improve its effluent treatment facilities to reduce harm to New Jersey waters. The court held that the Department of Health had jurisdiction over the pollution in Upper New York Bay and was empowered by statute to prescribed corrective improvements in defendant's treatment and demand compliance therewith. Absolute discretion, vested statutorily in defendant to determine the size and capacity of each sewerage works did not extend to the intensity of effluent treatment. Though the statute requiring submission to the Department's regulations was intended to enable the Department to supervise preconstruction waste treatment, except in those areas within the jurisdiction of defendant, it did not prevent the Department from requiring corrective measures by defendant to prevent pollution. The state's entering into a 1910 stipulation with federal authorities regarding pollution controls required of defendant did not preclude subsequent requiring of more stringent controls. Neither costliness nor difficulty of financing relieved defendant of it's obligation to cease polluting the waters. (Storace-W69-01341

FINK V BOARD OF TRUSTEES OF S ILL UNIV INJUNCTION )INJUNCTION AGAINST S DISCHARGE INTO STREAM(. 71 III App 2d 276, 218 NE 2d 240 (1966). **SEWAGE** 

Descriptors: \*Illinois, \*Sewage effluents, \*Sewage treatment, \*Intermittent streams, Water pollution, Effluents, Judicial decisions, Dams, Sewage disposal, Treatment facilities, Water pollution sources, Water pollution control, Water law. Identifiers: \*Injunction, Treated sewage, Remedies (Legal aspects), Sewage treatment plants.

This was a suit to enjoin construction of an upstream dam on an intermittent watercourse flowing past plaintiff's property and to enjoin defendant from discharging sewage effluent into such watercourse. Defendant placed a dam across one of two branches of the stream to impound a lake. Plaintiff's only complaint about the dam was that it would diminish the flow of water past his property. The court found the plaintiff's damage from the dam to be minimal and denied the injunction as to the dam. Below the dam defendant proposed to construct a sewage treatment plant and discharge treated effluent into the stream. Testimony by engineers disclosed two alternative methods for disposal of effluent from the plant: (1) By direct discharge into the stream; (2) By means of an outfall sewer line to carry off the effluent. At times, due to operational failure of the plant, low quality

effluent would flow into the stream. The court balanced the interests of plaintiff and defendant and granted the injunction against discharge of effluent into the stream. The injunction was proper even though the damage claimed by plaintiff was wholly prospective. (Kirkconnell-Fla) W69-01389

INTERACTION BETWEEN ALUMINUM AND PHOSPHATE IN AQUEOUS SOLUTION, Rutgers-the State Univ, New Brunswick, NJ, Dept

of Soils and Crops. For primary bibliographic entry see Field 02K. For abstract, see. W69-01407

STORM OVERFLOW PERFORMANCE STU-DIES USING CRUDE SEWAGE,

P. Ackers, A. J. Brewer, and A. E. Birbeck. Symp on Storm Sewage Overflows, May 4, 1967.

Descriptors: \*Overflow, \*Storm runoff, Sewage treatment, \*Weirs, \*Stilling basins, Flow control, \*Design, Discharge (Water).

Experiments were carried out to: (a) determine the difference in composition of storm sewage discharge from an overflow and that passed to treatment; (b) compare the performance of the different types of overflow; (c) examine the effectiveness of scum boards; and (d) measure the changes in flow to treatment with increasing total flow in each structure. The types of overflow tested were: (a) a low double side-weir; (b) a stilling pond; (c) a vortex; and (d) a high-level side-weir with a positive flow control. The structures tested were designed to operate under hydraulic conditions as nearly identical as possible. The overflows were designed to spill at a discharge to treatment of 1/10 the maximum discharge and, with the exception of the low side-weir, would limit the flow to treatment to 20% above the first spill discharge. The most practical form seemed to be the round-crested type. Measurements were made of: (a) the discharge to treatment at first spill; (b) the discharge to treatment and spill at various larger incoming flows; and (c) the water levels in the overflow chamber for these discharges. The high sideweir had the best general performance, second was the stilling pond with the scum board 6 in. from the crest, and the vortex overflow was the worst. W69-01494

THE QUALITY OF STORM WEATHER FLOW, Gunnar Akerlindh.

Satryck ur Nordisk Hygienisk Tidskreff, Vol 31, No 1. 1950.

Descriptors: \*Storm runoff, \*Overflow. \*Coliforms, Sewage, \*Water quality, \*Biochemical oxygen demand, \*Rain water. Identifiers: \*Combined sewers.

The quality of storm-water flow, particularly the surplus discharge from combined sewers, is discussed in order to compute the required regulated flow; that is, the amount of flow to be diverted for disposal. The three elements constituting stormweather flow--namely sewage, ground water, and rain water, have been considered. Coliform bacteria in samples taken from streets (high runoff coefficients) and parks (low runoff coefficients) were compared. The concentration of organic matter in rain water is comparatively great (B.O.D. 100 to 200 ppm) being nearly as polluted as sewage. In regard to coliform organisms, however, the rain water portion of the storm-weather flow has a density of 100 to 1,000 per ml and, accordingly, is much lower than sewage and has a diluting effect on the sewage. The composition of rain water flow varies greatly and indefinitely. Despite this, it is reasonable to assume a constant W69-01495

ENVIRONMENTAL FACTORS IN RELATION TO WATER USE AND PROTECTION AGAINST POLLUTION

National Inst of Water Research, South Africa. B. R. Allanson, M. R. Henzen, and O. J. Coetzee. Conference on the Problems Associated with the Purification, Discharge and Re-Use of Municipal and Industrial Effluents, Pretoria, 1964, pp 77-92.

Descriptors: Drainage, \*Chemical analysis, \*Water pollution, \*Runoff, \*Water quality. Identifiers: Urban drainage, \*Bacteriological

sampling.

Consideration is given to the conditions on the drainage surface of a catchment area which cause changes in the chemical and bacteriological quality of river water, to factors responsible for the self-purifying capacity of streams and rivers, and to criteria upon which the efficient use of South African rivers should be based. Data are included showing how the physical and chemical quality of surface waters is affected by natural factors (dissolved and suspended substances in rain water, access of ground water, and contact with geological formations), agricultural activities, and run-off from residential and industrial areas. W69-01496

#### SEWERAGE MANUAL AND DIRECTORY, 1963.

Canadian Municipal Utilities, 144 p.

Descriptors: \*Surveys, \*Storm runoff, \*Water pollution, Sewage treatment. Identifiers: \*Canada.

This publication contains a Manual Section (pp. 17-60, 135-138, and 140-141), giving information on various aspects of sewage treatment and disposal; a pictorial review of equipment (pp. 62-89); and a statistical section, giving details of the sewerage systems and sewage works in each province of Canada (pp. 91-113). The Manual Section includes articles on air utilization in sewage works (DUTTON, C. S.), including aerated detritus tanks, aerated channels, and types of equipment for aeration in the activated-sludge process; 'package' and 'compact' sewage-treatment plants (GRUNWELL, H.), with illustrated descriptions of representative plants, namely the 'Accelo-Biox', 'Rated-Aeration', 'Sparjair', 'Oxigest', and 'Septi-Robic' units, all of which are based on an extended-aeration process, and the 'Simplex' Corner Pocket Plant (based on the standard activatedsludge process), 'Clarigester' (providing primary treatment and digestion), and 'Oxigritter' (primary treatment); elutriation of digested sludge (SCOTT, G. T. G.); problems caused by synthetic detergents (BERRY, A. E.), including data on the concentrations of these materials in sewage, sewage-works effluents, river water, storm water, well water and laundries waste waters in Ontario, and the remedial measures taken; pumping in sewerage systems (MAC KENZIE, J. A., and TAITERSALL, J. K.); and instrumentation, control and automation for sewage works (SIMMONS, R. A. G.).
W69-01499

## **PROGRESS AT COLCHESTER SEWAGE-TREATMENT WORKS.**

Survr Munic Cty Engr, Vol 127, No 3840, pp 28-29, 1966.

Descriptors: Storm runoff. Identifiers: \*Storage tanks.

Progress on the construction of a new high-level inlet works and on the reconstruction of 2 highlevel storm-water tanks, at the Haven sewage works, Colchester, is reviewed and illustrated. W69-01503

WHAT TO DO ABOUT POLLUTION FROM STORM SEWAGE OVERFLOWS.

Wastes Eng, Vol 33, 1962.

Descriptors: \*Storm runoff, \*Overflow, Outlets, \*Chlorination, \*Ozone, Design, \*Water pollution, Sewage treatment.

Identifiers: \*Storm sewers, \*Urban drainage, \*New York (N. Y.).

In a symposium on the treatment of storm sewage overflows presented by the Sanitary Engineering Division, Metropolitan Section, American Society of Civil Engineers, the subjects discussed were frequency and composition of storm-sewage overflows: the effect of storm-water outfalls on waters around New York City; techniques of analysing and classifying harbour water; sewage and stormwater chlorination; treatment of storm-sewage overflows with ozone; design of facilities for chlorinating storm water; and design and operation of sewerage systems to minimize pollution. W69-01504

#### REPORTS ON THE PROGRESS OF APPLIED CHEMISTRY.

London, Society of Chemical Industry, 1963, Vol 48,800 p.

Descriptors: \*Water pollution control, \*Legislation, \*Storm runoff, Bioindicators. Identifiers: \*Bacteriological sampling

Progress in the various branches of applied chemistry is reviewed, with a comprehensive list of references appended to each chapter. The following are among the subjects considered. (1) Sewage, trade wastes and river pollution. MC NICHOLAS, J. (pp. 322-333). This review covers legislation to control pollution of surface waters and beaches, and studies on river pollution; effect of polluting materials on fish; storm sewage; percolating filters; activated-sludge process; sludge treatment; effects of synthetic detergents; treatment of trade-waste waters; and instruments for the control and monitoring of sewage-treatment processes. (2) Biodegradability of detergents. DICKER, D. W. G. (pp. 334-342). Current progress in the development of 'biologically-soft' anionic detergent materials and the control of 'hard' materials is outlined, followed by a review of work on the measurement of biological degradability and its relation to molecular structure; studies on non-ionic detergents, since their relative contribution to pollution will increase as biologically-soft anionic detergents come into general use; and studies on the toxicity of surface-active agents and the removal of alkylbenzenesulphonates from waste waters. Microbiology of water, sewage and industrial effluents. ALLEN, L. A. (pp. 532-541). This chapter covers the microbiology of water, especially sewage-polluted water, and of waste-treatment processes, particularly the various modifications of the activated-sludge process and the treatment of carbonization, cyanide, cellulose-manufacture and other trade waste waters. (4) Sampling for bacteriological examination. GIBBS, B. M. (pp. 541-549). Included in this review are sampling devices and techniques for the microbiological examination of water and mud. Other chapters of the report contain information on the disinfection of water by contain information on the disinfection of water by chlorination (p. 566) or ozonation (p. 602), demineralization of sea water using soluble phthalocyanine dyes to increase the rate of solar evaporation (p. 54), and the use of plastic pipes for drinking water (p. 622).

W69-01505

#### CHICAGO ACTS TO ATTACK COMBINED SEWER PROBLEM.

Civ Eng, Vol 38, No 8, p 99, Aug 1968.

Descriptors: \*Storm runoff, Standards, \*Manholes, \*Storm drainage

Identifiers: \*Chicago (Ill.), \*Combined sewers, \*Residential sewers, \*Urban drainage, Capacity.

The Chicago Metropolitan Sanitary District is planning separate facilities for storm runoff. In the meantime, it has issued an ordinance setting an interim policy for the issuance of permits within a 300-mile area now being served by combined sewers. Provisions of this new ordinance include: only one building drain is required to carry both building wastes and storm water runoff to the combined sewer but municipalities may require separate drains; industries must provide separate services to the control manhole for storm water and industrial wastes; on-site storm facilities for the attenuation of peak flows will be given consideration, but the final determination will be made by the local municipality; and in new construction, downspouting and surface drains to sewers are prohibited unless storm-water capacity has been provided or unless such drainage flows through detention and/or regulating devices.

#### 200 POLLUTERS GET THE WORD EARLY.

Eng News - Record, p 12, Feb 1, 1968.

Descriptors: \*Water pollution control. Identifiers: \*Combined sewers, \*Urban drainage, \*Sewer separation, Lake Michigan.

Included in a recent list of FWPCA recommendations on pollution in Lake Michigan is a statement that combined sewers be prohibited in all new urban areas and separated in all urban reconstruction projects. The recommendations call for the elimination of pollution from combined sewers in 55 cities by 1977.

#### A REVIEW OF THE LITERATURE OF 1966 ON WASTE WATER AND WATER POLLUTION CONTROL.

J Water Poll Control Fed, Vol 39, pp 689-749, 867-945, and 1049-1154.

Descriptors: \*Water pollution control, \*Chemical analysis, \*Sewage treatment, \*Storm runoff, Estuaries, Standards, Legislation.

In a review of literature published during 1966 on waste treatment and pollution control, subjects dealt with include methods of analysis (including automated chemical techniques); physical and chemical methods of sewage treatment; biological filtration; the activated-sludge process; disinfection of sewage; effects of synthetic detergents on sewage treatment and aquatic organisms; biodegradation of detergents; digestion, treatment, and utilization of sludge; recovery and re-use of sewage and trade waste waters as water supplies; design of sewerage systems and treatment of storm sewage; composting of garbage; treatment of specific types of trade waste waters; treatment, disposal, and polluting effects of radioactive waste waters; biological surveys of polluted waters; polluting effects of sewage and trade waste waters; toxic effects of metals, pesticides, and weedkillers; effects of thermal pollution; effects of pollution on the physiology of fish; bio-assay techniques; estuarine and marine pollution; microbiology of polluted waters; oxygen sag and self-purification; quality standards for streams; effects of pollution on water supplies; pollution of ground water; eutrophication of natural waters; use of systems analysis in managing water resources; and legisla-tion controlling pollution.

NINTH ANNUAL REPORT, FOR THE YEAR ENDED DECEMBER 31ST 1963. Water Research Association.

44p.

#### Field 05-WATER QUALITY MANAGEMENT AND PROTECTION

#### **Group 5D—Waste Treatment Processes**

Descriptors: \*Coliforms, Chemical analysis, Turbidity, \*Computer programs, \*Rainfall-runoff relationships, Groundwater recharge, \*Instrumentation, Rain gages, \*Sewer hydraulics, Pipes. Identifiers: \*Leak detection.

This report on the work of the Water Research Association contains individual sections on biology (development of synthetic media for use in the coliform test and methods for controlling algae); chemistry (coagulation of water, dewatering of water-works sludge, and methods for the determination of free and combined chlorine, turbidity, chemical oxygen demand (to avoid interference by chlorine) and traces of organic chemicals, pesticides, and herbicides); hydrology (particularly the use of an analogue computer to solve problems connected with the relations between rainfall, runoff, and evaporation, estimation of evaporation from catchment areas, and abstraction and artificial recharge of ground water, and development of instruments for measuring rainfall and stream flow); physics (detection of leaks and properties of pipes); and plant processes demineralization, and fluoridation). (coagulation, W69-01515

HYDRAULICS RESEARCH 1963 AND 1964. THE REPORTS OF THE HYDRAULICS RESEARCH BOARD WITH THE REPORTS OF OF THE DIRECTOR HYDRAULICS RESEARCH.

For primary bibliographic entry see Field 02E For abstract, see .

FIFTEENTH AND FINAL ANNUAL REPORTS OF THE BRISTOL AVON RIVER BOARD AND THE SEVERN RIVER BOARD FOR THE YEAR ENDED 31ST MARCH, 1965.

Bristol Avon River Board; Severn River Board.

46 pp, 2 pl; and 56 pp, 2 pl.

Descriptors: \*Water pollution control, Sewage treatment, Data collections, \*Standards, \*Storm runoff, Sewage effluents.
Identifiers: \*Suspended solids, Bristol (Great

Britain).

These reports each contain information on water resources and the prevention of pollution, including the characteristics of the water and the treatment of sewage and trade waste waters. Tabulated data are included from surveys of the rivers Severn and Avon and their tributaries; and for the Bristol Avon area, the classification of the watercourses is compared with that reported in 1958. In the Severn area, a high standard has been adopted for settled storm sewage, limiting the concentration of suspended solids to 100 p.p.m. based on the average of three consecutive samples. Owing to the excessive amounts of suspended matter often found in effluents from package sewage-treatment plants, the Severn River Board request that land treatment should be provided for these effluents. Recommendations have also been made regarding the design of oil-storage tanks to prevent pollution caused by accidents or misuse. W69-01518

NORTHUMBERLAND AND TYNESIDE RIVER BOARD. ANNUAL REPORTS FOR THE YEARS ENDED THE 31ST MARCH, 1962 AND THE 31ST MARCH, 1963.

Descriptors: \*Water pollution control, Water quality, \*Standards, Sewage effluents, \*Overflow, \*Storm runoff.

Identifiers: \*Storage tanks, \*Suspended solids, \*Great Britain.

These reports each contain a section on the prevention of pollution, with information on the quality of river water, instances of pollution and fish mortality, and remedial action, including a summary of new and projected schemes of sewage disposal. Average data obtained in analyses of the more important rivers and streams are appended. Standards for sewage effluents and trade waste waters are outlined. A new standard has been imposed requiring that effluents from storm-water tanks at sewage works shall not contain more than 100 p.p.m. suspended solids. It is not, however, considered practical to impose a standard on the storm-water overflows on sewage systems.

ANNUAL REPORTS OF THE SEVERN RIVER BOARD AND THE WYE RIVER BOARD FOR THE YEAR ENDED 31ST MARCH, 1963.

Descriptors: \*Water pollution control, \*Standards, Sewage effluents, \*Biochemical oxygen demand, \*Storm runoff, \*Overflow.

Identifiers: \*Combined sewers, \*Capacity, \*Great

These reports each contain sections on water resources, fisheries, and prevention of pollution. The basic standards for effluents are summarized; they have remained unaltered except that, following a decision by the Ministry of Housing and Local Government, no limitation is now imposed on the B.O.D. of discharges of partially-treated sewage or storm water. Progress in the construction of works to alleviate pollution of the Severn river system has been satisfactory but in many cases full advantage of the new sewage works cannot be taken in storm time until improvements to the main sewerage system have also been carried out. A number of sewage authorities have accepted the policy of the Severn River Board for reducing the storm product in combined sewers by the selective elimination of surface water, and the enlargement of main sewer capacities will permit closure of certain overflows. New storm overflows are not permitted except in exceptional circumstances.

#### NEW YORK STATE MUNICIPAL WATER AND SEWAGE,

For primary bibliographic entry see Field 04A For abstract, see W69-01525

#### CONTROL OF SEWER USAGE AT DETROIT, MICHIGAN.

C. L. Palmer

Sewage Works J, Vol 18, No 6, pp 1127-9, Nov

\*Standards, Sewage treatment, \*Discharge (Water), \*Storm runoff, Sewers. Identifiers: \*Detroit (Mich.).

Discussion of 'Standards and Regulations' in Detroit, that are to apply to point where industrial or commercial type wastes are discharged into public sewer; data on sewage treatment facilities and discharge of storm water to Detroit and Rouge Rivers W69-01528

STANDARDS AND TECHNICAL SPECIFICA-TIONS FOR PLANNING SEWERS IN IN-HABITED LOCALITIES,

A. N. Shevkun.

Vodosn Sanit Tekh, No 3, pp 1-5, 1957.

Descriptors: \*Standards, \*Sewers, Planning, Identifiers: \*Combined sewers, \*Russia.

The author reviews recent Russian regulations concerning the design of separate and combined sewerage systems and sewage works. W69-01530

#### FINE SCREENS FOR COMBINED SEWAGE.

Amer City, p 42, Dec, 1967.

Descriptors: \*Biochemical oxygen demand, \*Overflow, Sewage treatment. Identifiers: \*Combined sewers, \*Suspended solids.

A study to determine the feasibility, effectiveness and economics of providing primary treatments to reduce BOD and suspended solids from overflow of combined sewers is outlined. Combined sewage and overflow will pass through two fine-mesh vibrating screens each 7 ft. in diameter and one 60 inch horizontal screen. W69-01533

#### TESTS CHEMICAL TREATMENT OF STORM OVERFLOW.

Amer City, p 36, Nov, 1967.

Descriptors: \*Sewage treatment, \*Storm runoff, \*Overflow, Water pollution, \*Equipment. Identifiers: \*Storm sewers, \*Polymers, \*Suspended solids.

Work by Dow Chem. Co. under an FWPCA contract to determine the effectiveness of chemical treatment of storm-sewer overflow is described. Objectives of the study are: to detail the sequence of events that occurs during and immediately after storms, particularly the volume and pollutional content of the storm water; to determine the value of organic flocculants for the removal of suspended material from storm-sewer overflow; to study the effectiveness of several types of disinfectants in the waste flow; and to design equipment that will make effective use of chemicals. The polymers used are Purifloc flocculants. W69-01534

#### \$5,729,103 AWARD FOR WATER POLLUTION RESEARCH.

APWA Reporter, March 1968.

Descriptors: \*Water pollution control, \*Overflow, \*Storm runoff, Sewage treatment.
Identifiers: \*Combined sewers, \*Storage tanks, Jamaica Bay (N. Y.).

The FWPCA recently awarded several contracts concerned with methods to control pollution from overflows of combined sewers during storms, including an evaluation of a treatment plant for combined sewer outflows into Jamaica Bay, and construction and evaluation of a 2 million gallon combined sewage treatment and storage facility in New Hampshire. Demonstration contracts to find solutions to the combined sewer problem were awarded and include: a facility to treat wastes by microscreening, and facilities to demonstrate off-shore, underwater storage of storm water overflow, from combined sewers. W69-01535

#### TO RESTORE LAKE ERIE BEACHES.

ASCE - San Eng Div, Newsletter, p 6, May, 1968.

Descriptors: \*Recreation facilities, \*Water pollution control, \*Overflow flow control, \*Chlorination, Discharge (Water).
Identifiers: \*Combined sewers, \*Cleveland (Ohio),

\*Lake Erie, \*Interceptor sewers, Capacity, \*Polymers, \*Sewer flushing.

Cleveland, Ohio is attempting to restore some of its Lake Erie beaches polluted by overflows of combined storm and sanitary sewers. Methods under inoverflows and creek waters entering Lake Erie; (3) flushing sewers during dry weather to reduce the

#### Waste Treatment Processes—Group 5D

discharge of solids when it rains; (4) screening of overflows and streams. W69-01536

#### A PLAN TO HELP LAKE ERIE.

ASCE - San Eng Div, Newsletter, p 5, Jan 1967.

Descriptors: \*Overflow, \*Construction, \*Sewage lagoon, Sewage treatment.
Identifiers: \*Cleveland (Ohio), \*Storage tanks, \*Combined sewers, \*Lake Erie.

The feasibility of building a large waste-water holding and treatment reservoir in Lake Erie for combined-sewer overflows in Cleveland is being studied. The possibility of building a deep detention facility off the shore of Lake Erie is being investigated because of the high cost of acquiring valuable lakefront land there. Construction techniques will be analyzed and the best methods of operation to assure flexibility of use and efficiency of treatment will be recommended. If this proves to be feasible, the lagoon may provide further treat-ment of the wastes from Cleveland's Easterly secondary-treatment plant and flows from storm sewers in this section of the city. W69-01537

#### FEDERAL GRANT TO HELP RESTORE CLEVELAND BEACHES.

Civ Eng, Vol 38, No 6, p 85, June 1968.

Descriptors: \*Recreation facilities, \*Overflow, Flow control, \*Chlorination, Storm runoff, \*Water pollution control, Discharge (Water).

Identifiers: \*Combined sewers, \*Cleveland (Ohio),
\*Polymers, \*Lake Erie, \*Sewer flushing, \*Interceptor sewers, Capacity.

Cleveland. Ohio has received a grant to restore beaches polluted largely by overflows of combined sewers and to expand recreational opportunities for the area. Control and treatment methods to be used in this project include: experimental use of polymers to reduce overflows from the combined sewers by increasing the flow-carrying capacity of interceptor sewers; hypochlorination of the major overflows and creek water entering Lake Erie; implementation of a sewer-flushing program during dry weather to reduce the discharge of solids when it rains; and screening of overflows and streams. W69-01538

#### MILWAUKEE SEEKS TO SOLVE POLLUTION PROBLEM.

Civ Eng, Vol 37, No 9, p 79, Sept 1967.

Descriptors: \*Storm runoff, \*Overflow, \*Chlorination, \*Chemical analysis.

Identifiers: \*Milwaukee (Wis.), \*Storage tanks, \*Combined sewers, \*Bacteriological sampling.

Milwaukee will construct a huge underground concrete tank to catch rainstorm overflow from the combined sanitary-storm sewer system. The demonstration tank will be 170 ft. long, 130 ft. wide, and 30 ft. deep, and will hold 3.9 million gallons. The tank is being designed to catch the runoff, purify it with chlorine, or hold it until the storm ends. Then the runoff will gradually be drained back into the combined sewer system, which flows to the treatment plant. In addition to this demonstration project, the quality and quantity of the combined flow, including a physical, chemical and bacteriological analysis of the combined waste, will be made in an effort to determine when the sewers overflow or for how long. W69-01539

#### NEW ORLEANS HAS GRANT TO TREAT STORM WATER.

Civ Eng, Vol 37, No 3, p 103, Mar 1967.

Descriptors: \*Storm runoff, Recreation facilities, Water pollution, \*Overflow, \*Chlorination. Identifiers: Grants, \*Storm sewers, \*New Orleans (La.), \*Urban drainage.

Lake Pontchartrain beaches now have to be closed after heavy summer rains when storm water, with a high bacterial count, is pumped from the canals in New Orleans into the lake. Although New Orleans has separate storm-water and sewer systems, some overflow from the sewers into the canals carrying rain water does occur. In addition, the canal waters are contaminated by dirt washed off the streets during rains. A demonstration project is being initiated to study the injection of chlorine into storm waters in four open canals discharging into the lake. At one of the chlorine-injection stations a special concrete chamber, 1,300 ft. long, 85 ft. wide, and 14 ft. deep, will be built in a canal to assure that the chlorine will be adequately mixed with the storm waters. The project also involves the construction of a chlorine-blending plant to avoid the potential hazard of using the disinfectant in its gaseous form. W69-01540

#### IMPROVEMENTS TO SEWAGE TREATMENT AT BATH.

Civ Eng and Pub Wks Rev, Vol 63, No 738, p 70, Jan 1968.

\*Sewage treatment, \*Pumping, Descriptors: \*Storm runoff. Identifiers: Capacity.

Modifications to the City of Bath's sewage treatment system include the provision of new storm sewage treatment plant adjacent to their pumping station at Twerton, the plant now being designed to deal with some 17 m.g.d. under storm conditions, while a further 10.5 m.g.d. will be pumped 5 miles through a 30 in. rising main to the main treatment plant at Saltford. In order to connect the new pumping capacity, a temporary pumping was required to handle the full flow of sewage, so that the wet well could be isolated and work on connecting pipe work be carried out. For this purpose, the inlet chamber, measuring 6 ft x 5 ft. was converted to a sump to receive the full flow of sewage and 5 sykes 6 in. Univac pumps, working on a total suction lift of 25 ft. were installed. Normal peak mid-day and evening flows handled by the pumps are of the order of 250,000 gal/hr. With the wet well isolated, the 3 ft. thick dividing wall of the well was cut through using the ladder drilling method with holes at 4 in. centers being cut down by paving breakers to give an opening of some 4 ft. 6 in. square section. Old pipe sections which had to be removed were maneuvered through this opening by chain block and tackle before the new 24 in. dia. suction branches could be replaced.

#### ELMBRIDGE WATER POLLUTION CONTROL WORKS.

Civ Eng and Public Wks Rev, Vol 62, No 734, p 997, Sept 1967.

Descriptors: \*Storm runoff, \*Overflow, \*Sewage treatment, \*Sedimentation, \*Sewage sludge,

The new sewage disposal works at Cranleigh will deal with sewage flows up to 3 x D.W.F. and all storm flows will be treated in the old works which have been modified. At the storm overflow chamber, flows in excess of 3 x D.W.F. are overflowed to the old works for treatment in the sedimentation tanks, biological purification on four filters and secondary settlement in the humus tanks before discharge to the Cobblers Brook. In order to deal with these storm water flows, the first of the three sedimentation tanks has been equipped with a sludge scraping mechanism and the other two tanks have a ridged floor formed by precast concrete units to facilitate the removal of the sludge settling in these tanks. The old filters have

had new revolving distributors fitted and arrangements have been made to trickle feed these filters with settled sewage during dry weather. In this way, the micro-organisms which must be present to effect biological purification will be kept alive and the filters ready to treat the excess flows in wet weather. W69-01542

#### TUNNEL WILL STORE STORM RUNOFF.

Eng News Rec, Vol 179, No 22, p 32, Nov 30, 1967.

Descriptors: \*Overflow, Storm runoff, Treatment, Pumping, Tunnels. Identifiers: \*Combined sewers, Chicago (Ill.).

Chicago's Dept of Public Works tunnel is designed to hold excess flow from combined storm and sanitary sewer system in area during heavy rains; when rain runoff stops, pumps in tunnel will put sewage back into existing system leading to treatment plants; schematic drawings of tunnel and water diversion from combined line to tunnel.

#### PLANT WILL HALT STORM POLLUTION.

Eng News Rec, Vol 178, No 7, p 16, 1967.

Descriptors: \*Overflows, \*Sewage treatment, Solid wastes Identifiers: Storm sewers.

A description is given of the proposed system of centrifuging and air injection to be installed at the sewage works of Fort Smith, Ark., to remove solids from storm-sewage overflows which by-pass the works. A study will also be made of the system as part of the normal treatment process, functioning between the bar screens and the primary sedimen-W69-01544

#### SEATTLE SEES VICTORY IN ITS BATTLE AGAINST POLLUTION.

Eng News Rec, Vol 174, No 23, pp 44-46 and 51, 1965

Descriptors: \*Overflows, Sewage treatment. Identifiers: \*Storage tanks, Storm sewers.

The comprehensive sewage-disposal facilities planned for Seattle, Wash., to reduce pollution of Lake Washington and coastal waters of Puget Sound are outlined; the Renton and West Point treatment plants are now in operation. Some pollution is still likely to occur as a result of overflows of storm sewage; one proposal to reduce this is construction of holding tanks near Lake Washington. W69-01545

#### CITY PLANS TO TREAT STORM WATER.

Eng News Rec, Vol 172, p 22, May 28, 1964.

Descriptors: \*Storm runoff, \*Chlorination, \*Overflow, Recreation facilities, Design, Estuaries Identifiers: \*Storage tanks, \*Storm sewers, Capacity, \*New York (N. Y.).

Describes the 'Marginal Pollution Control Program' for New York City in and around Jamica Bay, Eastchester Bay and the Upper East River. Large detention tanks are being constructed with chlorination facilities at the storm sewer overflows. Tanks are designed to capture an estimated 25 of 40 summer storms with 15 overflowing. The initial phase of construction for Jamaica Bay will include 4 storm water detention tanks serving 12,663 acres. The above program is designed for protection of the cities bathing beaches. W69-01546

#### Field 05 - WATER QUALITY MANAGEMENT AND PROTECTION

#### Group 5D—Waste Treatment Processes

UNDERWATER STORAGE OF STORM OVER-FLOW.

Environ Sci Technol, Vol 2, No 9, p 668, Sept

Descriptors: \*Overflow, \*Storm runoff, Design, \*Flowmeter, Sewage sludge, Pumping Identifiers: \*Combined sewers, \*Storage tanks, \*Washington, D. C., \*Interceptor sewers, Suspended solids.

The feasibility of storing overflow of combined sewers in inflatable tanks anchored to the bottom of a river bed is being studied by a pilot project in the Anacostia River in Washington, D. C. The project is intended to demonstrate that this approach can capture, handle, store, and return overflow to the interceptor sewer without the overflow ever touching the river. The tanks are made of synthetic rubber impregnated with nylon fabric. They measure 120 x 20 feet, and stand between 6 and 7 feet high when inflated. In operation, the system will work this way: storm overflow passes through a Parshall flume where the volume is measured and recorded. At a predetermined level, a butterfly opens to allow influent to enter a grit chamber, where oils and grease float to the top and are skimmed off. The flow passes through a comminutor which shreds all solids down to 3/8 inch. The flow then moves by gravity to the storage tanks. When it is ready to be pumped back to the interceptor, compressed air is used to prevent sludge W69-01547

#### UNDERWATER TANKS WILL STORE RUN-OFF WATER.

Environ Sci Technol, Vol 2, No 3, p 169, March 1968

Descriptors: \*Storm runoff, \*Overflow, Design. Identifiers: \*Storage tank.

Underwater tanks to store excess sewage and runoff waters during overflow conditions will be designed, constructed, and operated by Melpar, Inc. The stored water will be returned to the municipal treatment plant when conditions are more favorable. The tank will be located on the river bottom several hundred feet from shore and will not be a hindrance to navigation.

#### NEW ORLEANS TRYING DISINFECTION OF STORM-SEWER DISCHARGES.

Publ Wks, NY, Vol 98, No 3, p 139, 1967.

Descriptors: \*Storm runoff, \*Chlorination, Recreation facilities.

Identifiers: New Orleans (La.), Storm sewers.

Pollution of Lake Pontchartrain through the discharge of storm sewage from New Orleans into canals, has occurred, leading to closure of the beaches after heavy rains when the canal contents are pumped into the lake. To remedy this, it is planned to chlorinate the storm sewage in the canals.

W69-01549

#### MILL GREEN SEWAGE DISPOSAL WORKS EXTENDED.

Survr Munic Cty Engr, Vol 129, No 3912, pp 27-28, 31, 1967.

Descriptors: \*Storm runoff, Treatment. Identifiers: Storage tanks.

An illustrated description is given of recent extensions to the Mill Green sewage works of Hatfield R.D.C., Herts., which serve the northern part of Hatfield and neighbouring villages. The new works, designed for a flow of 1 m.g.d., include increased

pumping capacity, additional percolating filters and 3 microstrainers for tertiary treatment of humus-tank effluent before discharge to the river Lee. Storm sewage is returned for full treatment after storage. After two-stage digestion, sludge is dried on beds. W69-01550

#### WORTHING'S L500,000 SCHEME OF DRAINAGE IMPROVEMENTS.

Surveyor, London, Vol 121, pp 1069-1070, 1962.

Descriptors: Storm runoff. Identifiers: \*Storage tanks

Improvements are being made at the overloaded sewage works of Worthing, Sussex, where previously sewage was discharged to sea after screening and chlorination. At the West Worthing works, which will treat a dry-weather flow of 1.31 m.g.d., the screens are being replaced by comminutors, and sedimentation tanks and new storm-water tanks are being constructed. At the East Worthing works (which will have a dry-weather flow of 3.14 m.g.d.) improvements include the enlargement of the existing pumping station, installation of a comminutor, conversion of the existing tidal storage tanks to storm-water tanks, and construction of new storage tanks. The effluents will be discharged over a tidal period of 8 1/2 hours. Sludge from both works will be combined with refuse and sold as W69-01551

## CALCUTTA. 2. A SANITARY ENGINEERING APPROACH TO A MULTIPLICITY OF PROBLEMS,

P. C. Bose, and R. G. Ludwig. Water Sewage Works, Vol 112, pp 164-167, 1965.

Descriptors: \*Flood control, Drainage systems, \*Design, Storms, Sewage treatment, \*Storm runoff.

Identifiers: \*Capacity, \*Combined sewers, \*Storm sewers, Calcutta (India).

To improve the sewerage system at Calcutta and alleviate flooding during the monsoon period it is proposed to increase the capacity of the existing combined sewers and drainage channels, provide connexions to the trunk sewers, and construct separate sewers for storm water and sewage in the unsewered districts, using 2-month storm frequency data as a design basis for the urban sections. Treatment works are planned for the districts of Tollygunge, Cossipore-Chitpore, Howrah, and Chandernagore. W69-01562

## UNIT HYDROGRAPH CHARACTERISTICS FOR SEWERED AREAS,

Peter S. Eagleson. ASCE Proc, J of Hydr Div, Vol 88, No HY2, Part 1, March 1962.

Descriptors: \*Hydrographs, \*Overflow, Sewers, Storms, Drainage.
Identifiers: \*Storm sewers.

Hydrographs of measured storm sewer outflow from urban areas up to 7.5 sq. miles in size are analyzed. The characteristics of the hydrographs are correlated with the properties of sewers and drainage basins in order to permit construction of synthetic unit hydrographs for other unmeasured sewered areas. Applicability of the derived relationships is tested against a measured outflow hydrograph for a complex storm.

## LIMITING FACTORS IN RAINFALL RUN-OFF, For primary bibliographic entry see Field 02A. For abstract, see . W69-01589

## RAINFALLS OF SHORT DURATION AND HIGH INTENSITY: AN ALTERNATIVE TO BILHAM'S FORMULA,

For primary bibliographic entry see Field 02A. For abstract, see . W69-01590

## WATER AND WASTE-WATER ENGINEERING. I. WATER SUPPLY AND WASTE-WATER REMOVAL,

G. M. Fair, J. C. Geyer, and D. A. Okun. New York, Wiley, 1966. 1246 p.

Descriptors: Design, Sewers, \*Rainfall-runoff relationships, Surface runoff, Groundwater, Equipment.

Identifiers: \*Storage tanks.

This book is based on a previous publication produced in 1954 and is designed to help students of civil and sanitary engineering to understand the principles of water supply and waste disposal. Chapters are included on water-supply and sewerage systems; information analysis; water requirements and volumes of sewage; relations between rainfall and runoff and the control and storage of runoff; flow and collection of ground water and surface water; transmission and distribution of water; collection of sewage; design and operation of machinery and equipment; optimization techniques; and carrying out of engineering projects. Information and conversion factors are given in an appendix, and a bibliography and subject index are included.

W69-01591

#### 5E. Ultimate Disposal of Wastes

#### KREMEYER V SHUMATE )DEBRIS-PLUGGED DRAINS(.

20 111 App 2d 542, 156 N E 2d 271-274 (1959).

Descriptors: \*Illinois, Judicial decisions, Debris avalanches, \*Garbage dumps, \*Landfills, Gullies, Ravines, Ditches, Drains, \*Damages, Fouling, Flood damage, Floods water injury.

Defendants, operators of a scavenger business, deposited garbage, debris and junk on their property. A portion of this debris was used to fill ditches and gullies in which a ravine terminated. A severe rain washed debris from the dumping place and carried it down through the ravine onto plaintiffs' property, where the water-borne debris plugged up the end of a drainage pipe running beneath plain-tiffs' front yard. Plaintiffs' sued for damages to their property from flooding allegedly caused by the plugging of the pipe. The court awarded plaintiffs' a reasonable amount to unplug the drain but denied any recovery for permanent damage to the real property, holding that plaintiffs had not satisfied their burden of establishing a causal connection between the negligent piling of the garbage and the eventual damage to improvements on plaintiffs' land. W69-01321

## POWER OF MASSACHUSETTS METROPOLITAN DISTRICT COMMISSION. Mass Ann Laws ch 92, secs 75-79 (1967).

Descriptors: \*Massachusetts, \*Administration, \*Water permits, \*Eminent domain, Legislation, Administrative agencies, Cities, Water pollution, Pollution abatement, Construction, Water pollution sources, Sewage disposal, Industrial water, Government finance, Water utilization, Water levels, Water quality, Drainage, Sewers, Reservation doctrine. Identifiers: Harbor masters, Public hearings.

Section 75 empowers the Metropolitan District Commission to appoint a harbor master and assistant harbor masters to exercise authority within the Charles river basin. Section 76 authorizes the commission to order the removal of

Water Quality Control—Group 5G

all sewage and other polluting matter from the Charles River. Section 76A gives the commission authority to issue permits for the taking of water from the Charles river basin for the purposes of fire protection and sale to manufacturing establishments. Specified conditions must be met before a permit is issued. Section 76B specified conditions under which the permit is granted; violation of any condition is ground for revocation. Sections 76C and 76D pertain to suitable connections for use of city water in case of revocation, and to mainenance of the water level in the river basin. Secuon 76E permits cities to borrow money to finance construction of water works. Section 77 empowers the commission to take by eminent domain any lands for the purpose of sewage disposal. Section 78 deals with eminent domain powers for construction, maintenance, and operation of a system of metropolitan water works. Section 79 deals with eminent domain for reservations. (Smodish-Fla) W69-01328

### AN ACT PROHIBITING THE DISPOSAL OF GARBAGE AND REFUSE IN COASTAL OR IN-LAND WATERS.

Massachusetts Laws ch 116 (1967).

Descriptors: \*Massachusetts, Legislation, \*Water pollution control, Inland waterways, \*Solid wastes, \*Domestic wastes, Water quality.

Chapter 270, Sec 16 of the General Laws, relating to the disposal of garbage and refuse, is expanded to include coastal or inland waters, whether they are salt or fresh water, and areas within twenty yards of such waters. (R. F. Williams-Fla) W69-01331

AN ACT SUBJECTING CERTAIN PERSONS WHO DISCHARGE OIL AND PETROLEUM PRODUCTS INTO CERTAIN INLAND WATERS AND INTO TIDAL WATERS TO TORT LIABILITY IN DOUBLE DAMAGES. Massachusetts Laws ch 507 (1967).

\*Massachusetts,

Legislation, Descriptors: Damages, \*Legal aspects, Water pollution, Oil, \*Oil wastes, Oily waters, Inland waterways, Tidal

Identifiers: Damages (Legal aspects).

Section 59A is inserted in Chapter 91 of the General Laws. It provides that anyone who negligently pumps or discharges oil or oil wastes into any lake, river tidal waters or flat so that the property of another is damaged, shall be liable in tort for double damaged, shall be liable in damaged property. (R. F. Williams-Fla) W69-01332

### SHIPPING, SEAMEN, AND PORTS: IN GENERAL.

98 Ga Code Ann Secs 101-105 (1967).

Descriptors: \*Georgia, Legislation, \*Navigation, Ships, \*Local governments, Bays, Harbors

Owners of boats employed in navigation of the navigable waters of the state are required to furnish a bill of lading to each boat before it leaves for its destination. Dumping of any ballast in a bay or harbor, or within three miles thereof is forbidden, and a penalty is provided. Any pilot failing to inform the authorities of such an offense shall be deprived of his license. Attachment may be used to collect the fine specified as the penalty for unlawful dumpare granted the authority to prohibit the throwing of any substances into navigable waters within their respective jurisdictions. (R. F. Williams-Fla) W69-01333 ing of ballast. The city councils of towns and cities

SEWAGE DISPOSAL. L. J. A. Stow.

Surveyor Vol 106, p 567, 1947.

Descriptors: \*Water pollution, \*Standards, \*Storm runoff, Sewage effluents. Identifiers: \*Great Britain.

The author discusses the existing state of river pollution in Great Britain with special reference to the need for standards for sewage works effluents, and for more complete treatment of all storm water. W69-01531

### 5F. Water Treatment and **Quality Alteration**

### MATHEMATICAL MODEL FOR DETERMIN-ING THE OPTIMAL SIZES OF WATER TREAT-

MENT PLANTS. Harvard Univ., Cambridge, Mass., Harvard Water Resources Group

For primary bibliographic entry see Field 06A. For abstract, see

W69-01213

## EUTROPHICATION AND WATER POLLU-

Federal Water Pollution Control Administration, Washington

Edward J. Martin, and Leon W. Weinberger. Publication Number 15, Great Lakes Res Div, Univ Mich, pp 451-469, 1966. 19 p, 4 fig, 8 tab, 45 ref.

Descriptors: \*Eutrophication, \*Nutrients, Pollu-tants, Pollution abatement, Nuisance algae, Phosphates, Nitrates, Rivers, Sewage treatment, Water pollution sources, Primary treatment, Secondary treatment, Tertiary treatment, Electrodialysis, Ion exchange, Activated sludge, Denitrification.

Authors define the mechanism of eutrophication and evaluate probable sources and nature of the pollutional loads responsible for accelerated eutrophication. This involves considerations of types and quantities of nutrient material, especially nitrogen and phosphorus, in terms of control and the frequency and intensity of algal blooms. On rivers, between 1961 and 1963, 49% of 130 stations reported algal counts which could be defined as blooms; 55% of 345 stations reported values of phosphate equaling or exceeding 0.2 mg/1. Wastes resulting from municipal, agricultural, and industrial uses of water contribute significant amounts of nutrients that may promote eutrophication in waterways. About 235 to 2,350 tons of phosphate are discharged daily to receiving waters from mu-nicipal waste sources in the US alone. Maximum efficiences of seven treatment processes for removing nitrogen and phosphorus are reviewed. 50% of total phosphorus and 80% of total nitrogen are removed by use of an activated-sludge process, while 99+% of the phosphorus and nitrogen are removed with a treatment sequence using ion exchange. These data indicate that treatment capabilities are available to control the discharge of nutrient compounds from point sources of wastes and to treat them to almost any desired degree.

### 5G. Water Quality Control

APPLICATION OF DECISION THEORY TO SANITARY ENGINEERING DESIGN PROBLEMS.

Harvard Univ., Cambridge, Mass., Harvard Water Resources Group.

For primary bibliographic entry see Field 06A For abstract, see W69-01212

WATER QUALITY IMPROVEMENT PRO-GRAMMING PROBLEMS, Stanford Univ., and Stanford Research Institute, Stanford, Calif.

For primary bibliographic entry see Field 06A. For abstract, see W69-01219

### PLANNING RATIONAL WATER POLLUTION CONTROL POLICIES.

Cornell Univ., Ithaca, N. Y For primary bibliographic entry see Field 06A. For abstract, see . W69-01223

## A STUDY OF THE INTERACTIONS AND FOAM FRACTIONATION OF SEWAGE EFFLUENT-ACID MINE DRAINAGE MIXTURES,

Pennsylvania State University, University Park. Robert C. Streeter, and Daniel C. McLean. Water Resour Res Publ No 6-66, Pa State Univ, 1966, 51 p, 7 fig, 6 tab, 28 ref. OWRR Project A-004-Pa.

Descriptors: \*Sewage, \*Sewage treatment, Sewage effluents, Foams, Oxygen demand, Aeration, pH, Waste water, Waste disposal, Laboratory equipment, Oxygen requirements, Dissolved solids, \*Surfactants, Acid mine water, \*Mine drainage, \*Foam fractionation.

This report encompasses removal of surfactants (derived from sewage effluent) and iron salts (derived from acid mine drainage waters) from contaminated Pennsylvania streams by foam fractionation techniques. Introduction of biodegradable surfactants to the market shortly after project initiation caused the foaming characteristics of treated domestic sewage effluents to be so poor as to obviate foam fractionation. However, a simple conbination of excess volume of sewage effluent with acid mine drainage (AMD) was found to result in significant water purification interactions. Sewage effluent-AMD mixtures were subjected to aeration, fluid-solid separation, and foam fractionation in a continuous process involving relatively short retention times and utilizing inexpensive equipment. Desirable results of this treatment are given. Precipitation of ferric hydroxide, which occurs when sewage effluent-AMD mixtures are neutralized, results in removal (by co-precipitation or absorption) of certain objectionable inorganic anions and refractory organic materials normally resistant to conventional sewage treatment. The average sewage treatment plant should be able to handle the quantities of AMD involved without loss of treatment capability or decrease in capacity, in fact, an increased capacity should be experienced. W69-01227

### HANDBOOK OF POLLUTION CONTROL COSTS IN MINE DRAINAGE MANAGEMENT. Fed Water Pollut Contr Admin, Dec 1966. 54 p, 13 fig, 2 tab, 49 ref.

Descriptors: Mine water, Economics, Costs, \*Mine drainage, \*Mine wastes, Strip mines, Grouting, Strip mine wastes, Coal mines, Coal mine wastes, Acid mine water, \*Pollution abatement, Waste

Identifiers: \*Monongahela River Basin, Monongahela River (Pa).

The information presented in this publication answers a need of the Monongahela River Mine Drainage Remedial Project for preliminary cost data in determining relative costs of mine drainage abatement. Costs of remedial measures are listed and evaluated on a unit price basis. They cover a period of 33 years from 1933 to the present time. These include unit costs on such items as mine seals or bulkheads; surface reclamation of strip-mines along with associated planting; reclamation of refuse areas; drainage diversion and impoundment; and treatment of mine drainage. Methods examined are grouped into those dealing with un-derground mine drainage, surface mine drainage, drainage from refuse and waste disposal areas, and control and treatment of water in active mining situations. W69-01236

## Field 05-WATER QUALITY MANAGEMENT AND PROTECTION

## Group 5G—Water Quality Control

WATER TRANSLOCATION OF DIAZINON-CARBON 14 AND PARATHION-SULFUR 35 OFF A MODEL CRANBERRY BOG AND SUB-SEQUENT OCCURRENCE IN FISH AND MUS-SELS.

Massachusetts University, Cranberry Experiment Station, East Wareham.

C. W. Miller, B. M. Zuckerman, and A. J. Charig.

Rep Trans Amer Fisheries Soc, Vol 95, No 4, pp 345-349, Oct 1966. 5 p, 2 tab, 9 ref, disc. OWRR Project A-010-Mass.

Descriptors: \*Pesticides, Fish physiology, Pesticide toxicity, Fish, \*Diazinon, Translocation, Runoff, Metabolism, \*Pesticide residues, Mussels, \*Cranberries, Bogs.

Transportation of diazinon-carbon 14 and parathion-sulfur 35 off a model cranberry bog following a simulated rost protection flood was shown 24 hr after application of the chemicals. Fish and fresh water mussels were exposed to these contaminated waters and analyzed periodically. The majority of the chemicals disappeared from the water after 144 hr. During this time, no labeled metabolites of diazinon were detected; however, three labeled parathion degradation products were encountered. Accumulation of both pesticides occurred in the fish and mussels, often to levels far in excess of that present in the waters. The fish appear able to metabolize these accumulated chemicals at a faster rate than the mussels.

## THE EFFECTS OF WEIRS ON THE AERATION OF FLOWING STREAMS.

Rhode Island University, Kingston. Warren M. Hagist.

Water Resour Center Completion Rep, Univ R 1, June 1967. 8 p. OWRR Project A-007-RI.

Descriptors: \*Acration, \*Weirs, Channel flow, Oxygen, Waste water treatment, Laboratory tests.

The purpose of the research was to perform a systematic investigation of the effect of weirs on the aeration of flowing streams. The experiments were performed in a rectangular laboratory channel using (1) a single suppressed weir with and without a downstream step of variable height and width, (2) two suppressed weirs in tandem, (3) a single contracted weir with and without a downstream step of variable height and width. The upstream and downstream oxygen concentrations were measured with a continuous reading oxygen analyzer. For the weirs without steps maximum oxygen pick-up occurred when the depth of the downstream water was about 1/3 the weir height. The presence of the downstream step doubled the aeration efficiency. The width of the step made almost no difference, but a step height of between 3/4 and 5/6 the weir height produced maximum aeration. Aeration efficiency of weirs is low, but their low installation and operating costs are attractive. (Author) W69-01257

## WATER POLLUTION - ECONOMIC ASPECTS AND RESEARCH NEEDS,

Allen V. Kneese.

Washington, D. C. Resources for the Future, 1962 107 p, 104 ref, 2 append.

Descriptors: Impaired water quality, Pollutant identification, Public health, \*Water pollution, \*Water pollution effects, Water pollution sources, Pollution abatement, \*Water pollution treatment, Water quality control, Social aspects, Economic efficiency, Economic impact, River basin development, \*Model studies, Analytical techniques, Optimization, Optimum development plans, Operations research, Water pollution control, Sewage

The economic consequences of water pollution are discussed thoroughly. An economic framework is established to determine research needs. The nature, effects, treatment and alternatives to treat-

ment of water pollution are delineated. Economic efficiency and social policy are discussed in relation to the pollution problem, and individual values and social values are evaluated. It is concluded that the results of unregulated wastes disposal into bodies of water fail to coincide with the attributes of an ideally functioning market system. It is suggested that a broad goal of public policy should be to minimize the social costs associated with wastes disposal. Research needs are discussed primarily in light of the complex problems involved. Computational and scientific problems, deficiencies in technical and economic knowledge, and problems in devising procedures for approximating optimum systems are examined. Several lines of investigation are suggested, and areas in which critical improvements in knowledge are needed are identified. (Pfeiffer-Fla) W69-01269

## ECONOMIC EFFICIENCY, SOCIAL POLICY, AND THE POLLUTION PROBLEM.

For primary bibliographic entry see Field 06B. For abstract, see . W69-01271

### DIVISION OF WATER POLLUTION CONTROL.

State of Massachusetts, Boston. For primary bibliographic entry see Field 06E. For abstract, see . W69-01296

### GEORGIA WATER QUALITY CONTROL ACT.

State of Georgia, Atlanta. For primary bibliographic entry see Field 06E. For abstract, see . W69-01300

AN ACT CREATING A POLLUTION CONTROL AGENCY AND CREATING AN OFFICE OF DIRECTOR THEREOF: PROSCRIBING THEIR POWERS AND DUTIES: EMPOWERING THE GOVERNOR TO ACT IN AN EMERGENCY. State of Minnesota, St. Paul.

For primary bibliographic entry see Field 06E. For abstract, see .

# AN ACT TO AMEND SECTION 16 OF 'AN ACT TO ESTABLISH A SANITARY WATER BOARD AND TO CONTROL...POLLUTION...'

Illinois Laws ch H 1177 (1967).

W69-01304

Descriptors: \*Illinois, \*Legislation, \*Water pollution control, Cities, \*Administrative agencies. Identifiers: Federal Water Pollution Control Act, Sanitary districts.

An act establishing the Sanitary Water Board in Illinois is herein amended. The effect of the amendment is to allow the board to set and enforce water quality standards for existing sanitary districts with populations of 1,000,000 or more; specifically, the Metropolitan Sanitary District of Chicago. This statewide control by the board is required for Illinois to receive benefits under the Federal Water Pollution Control Act. (Sisserson-Fla) W69-01314

# AN ACT...RELATING TO WATER RESOURCES, THE WATER POLLUTION CONTROL ACT, AND...DUTIES...OF THE DIVISION OF WATER RESOURCES AND THE WATER RESOURCES BOARD.

Laws of West Virginia 1967 ch 143.

Descriptors: Legislation, Water law, Water control, Public health, Administrative agencies, \*West Virginia, State governments, Water policy, Water resources development, Water flow, Permits, \*Environmental sanitation, Water purification, Water

pollution, Water resources, \*Pollution abatement, Water pollution treatment, Industrial wastes, \*Water pollution control, Sewage treatment, Sewage disposal.

This act amends the code of West Virginia pertaining to water pollution control. The act provides a general declaration of policy reflecting primary concern for the protection of public health and preservation of natural water resources. In addition, it encompasses definitions of terms used; the general powers and duties of the chief of the division of water resources and the water resources board with respect to water pollution; requirements for permits for specified activities; applications for and forms of permits; permit fees; procedures concerning permits; the transfer of permits; orders of the chief to stop or prevent discharges or deposits; orders of the chief to take remedial action; service of orders; duty to proceed with remedial action upon receipt of permit; progress reports; finances and funds; appeals to and review procedures before the water resources board; circuit courts and the supreme court of appeals; actions to abate nuisances; injunctive relief; violations; and criminal penalities. (Kuder-Fla) W69-01317

# AN ACT...RELATING TO THE APPOINTMENT OF VOLUNTARY WATER QUALITY MONITORS.

West Virginia Laws ch S 334 (1967).

Descriptors: \*West Virginia, Legislation, Administrative agencies, \*Water quality control, \*Water pollution control, Legal aspects, Monitoring, Onsight data collections, \*Sampling, Water analysis, Pollutant identification.

Section 8A was added to Article 5A, Chapter 20 of the Code of West Virginia (1931). Article 5A was entitled the 'Water Pollution Control Act.' The new section authorizes the appointment of volunteer water quality monitors. These monitors are to take samples of the waters of the state and forward them to the state water resources chief for analysis. The monitors are to be provided with training and equipment to perform these duties. They are to be paid fifty cents for each sample. These samples are admissable in all state courts for the purpose of enforcing the pollution laws. (Sisserson-Fla) W69-01318

# CITY OF UTICA V WATER POLLUTION CONTROL BD )AUTHORITY OF WATER POLLUTION CONTROL BOARD(. 5 NY 2d 164, 156 NE 2d 301-306 (1959).

Descriptors: \*New York, Judicial decisions, Administrative decisions, Local governments, State governments, Water pollution, \*Pollution abatement, \*Public health, Abatement, Classification,

The state legislature passed a water pollution control law that directed the defendant water pollution control board to employ experts to classify waters of the state. When making these classifications the defendant was to consider many specifically enumerated factors. Acting under the authority of this statute, defendant adopted classifications and standards of quality and purity, and assigned the same to waters within the plaintiff's area. Defendant then submitted to plaintiff a pollution abatement plan. Plaintiff did nothing to abate the pollution for two years, at which time defendant charged plaintiff with violating sections of the public health law. Plaintiff then brought this action to restrain defendant from acting on the ground that the water pollution law was unconstitutional. The court held that the act was a valid delegation of authority by the legislature, and that it provided adequate standards for the board's guidance. The legislature could confer discretion upon an agency if, as was done here, it had stated an intelligible principle and specified the standards and guides in as detailed a fashion as is reasonably practicable in the light of

he complexities of the particular area to be reguated. The court affirmed the dismissal of plaintiff's action. (S. Scott-Fla) N69-01322

TOWN OF WATERFORD V WATER POLLU-TION CONTROL BD )FINANCIAL CON-SIDERATIONS AND WATER CLASSIFICA-MON(. 5 NY 2d 171, 156 NE 2d 427-443 (1959).

Descriptors: \*New York, Judicial decisions, Adninistrative decisions, Local governments, State overnments, Water pollution, Pollution abatement, Public health, Abatement, \*Classification, standards, \*Financial feasibility, \*Economic bility, Financing, Costs, Project planning

Plaintiff instituted this proceeding to challenge the ight of defendant to assign a certain classification o certain waters in its area on the ground that the defendant failed to give any consideration to the iscal and economic aspects of its classification. The court held that under the act creating the poard, the defendant was not required to consider probable costs, relative priorities, or problems of nunicipal financing when adopting a classification of particular waters. Financial disability might impede the construction of the facilities needed to comply with the adopted classifications; however, the proper relief is not the annulment of the assigned classification, but rather an extension of time in which to effect the needed improvements. The court affirmed the defendant's assigned classification, holding that the raising of financial considerations was premature. (S. Scott-Fla) W69-01323

METHODS FOR HARVESTING OR CONTROL OF AQUATIC PLANTS,

Wisconsin Univ, Madison, Water Resources

Center. Jere Neil Mossier.

Descriptors: \*Eutrophication, \*Harvesting, \*Aquatic weed control, \*Lakes, Ecology, Primary production, Aquatic habitats, Sediment control, \*Harvesting, Water quality control, Vegetation, Watershed management, Plant growth, Vegetation regrowth, Scuba diving, Wisconsin.

Identifiers: Lake Mendota, Ceratophyllum, Myriophyllum, Vallisneria.

Analysis of three 800-sq-m submerged stands in Lake Mendota, Madison, Wis, demonstrated harvesting submergent macrophytes to be a feasible control procedure. Two stands with Myriophyllum exalbescens dominant and Ceratophyllum demersum subdominant were subjected to variable harvest treatments from June through August.
Myriophyllum at water depths of 1.4-2.1 m was controlled by one harvest; mid-July harvest appeared most effective. Myriophyllum at 1.0-m depth required two harvests; June-August combination appeared best. With decreasing depth, rate of macrophytic growth increases, making more frequent cutting necessary. Vallisneria americana at 1.0-1.6 m required only one harvest regardless of depth. Two transects were harvested mechanically. Growth responses of Myriophyllum and Ceratophyllum in these corresponded to responses of plants cut with hand sickles using SCUBA. An economical system to utilize the harvested crop is needed. New uses for Myriophyllum as animal feed or fertilizer may encourage investments in mechanical harvesting. Complete removal of plants from University Bay is not a sound ecological venture. Macrophytes reduce the distance silt and suspended matter are carried into the lake system and provide for biotic needs. The possibility of overharvesting is real; change in species composition with change in the environment is inevitable. Harvesting measures must be ecologically sound. W69-01399

WATER QUALITY AND RESOURCES ALLO-CATION BY PRIVATE MARKETS,

Resources for the Future, Inc. For primary bibliographic entry see Field 06B. For abstract, see . W69-01401

### STANDARDS, CHARGES, AND EQUITY,

Resources for the Future, Inc. Allen V. Kneese, and Blair T. Bower. Managing Water Quality: Economics, Technology, Institutions, Baltimore: Johns Hopkins Press, 1968, Chap. 7, p 131-142, 3 fig, 3 ref.

Descriptors: \*Water quality control, \*Economic efficiency, Administrative costs, Comparative costs, Economic evaluation, Competing uses, Optimum development plans, Economic justification, \*Marginal costs, Market value, Payment, Water Variable costs, Institutional constraints. Identifiers: Effluent charges, Equity.

Possible standards for water quality in streams, lakes, and estuaries are discussed. 'Complementarities' in treatment or other measures for reduction of waste discharges are reviewed with consideration of effluent standards. The effluent charge can be used to achieve stream water quality standards efficiently, i.e. at lowest economic or resource cost. Each waste discharger is charged in proportion to the use he makes of a resource - the waste assimilative and transport capacity of the watercourse. The waste discharger can compare his marginal costs and marginal charges and decide whether it pays him to reduce his waste and to what degree. The revenue that accrues to the agency from the charges can be viewed as a rental return on a natural resource. Ideally, charges should be levied on all activities which reduce water quality sufficiently to impose external costs, but this may not be administratively feasible. A discussion of the equity of charges which focuses on the distribution of costs of water quality management is presented. (Gargola-Chicago) W69-01402

### REPORT ON MULTILEVEL OUTLET WORKS AT FOUR EXISTING RESERVOIRS,

Bureau of Reclamation, Denver, Colo., and Sacramento, Calif.

Garry H. Austin, Donald A. Gray, and Donald G.

Pap Selec Withdrawal Reservoirs ASCE Hydraul Div conf, Cambridge, Mass, Aug 1968. 38 p, 12 fig.

Descriptors: \*Outlet works, \*Outlets, \*Water quality, Multiple purpose reservoirs, Intake gates, Intake towers, Intake structures, Discharges, Fish and wildlife, Reservoir operation, Hydraulic structures, Hydraulic gates and valves, Fish.

Identifiers: \*Multilevel outlets, Water temperature, Water use, \*Water quality control, Salmon, California, Selective level releases.

Design and performance of 4 multilevel outlet works constructed by the Bureau of Reclamation are discussed. The need for water quality control by selective reservoir releases has increased as more multipurpose reservoir applications have combined such diverse uses as irrigation, power generation, flood control, municipal and industrial water supply, fish and wildlife, recreation, and navigation. The 4 reservoirs (Cachuma, Casitas, Folsom, and Whiskeytown) have been in operation from 6 to 13 yr and present some variation in water quality situations and outlet designs. Cachuma and Casitas Reservoirs are thermally stratified during summer. Taste and odor requirements have governed the withdrawal level selection, but chlorine demand, temperature, and dissolved ox-ygen are considered. Modifications were made at Folsom Dam after completion to allow withdrawal of reservoir water from upper and lower levels. Salmon spawning requirements downstream from Folsom fix the maximum water temperature at 58 deg F. Selective withdrawal provisions at Whiskeytown Dam were planned for temperature control of

releases to Clear Creek, a salmon spawning stream. (USBR) W69-01437

#### RECLAIMED WATER WILL HELP FILL LAKES.

Publ Wks, NY, Vol 96, No 3, pp 82-83, 1965.

Descriptors: \*Storm runoff, Drainage, Tunnels, Design flow, \*Water reuse. Identifiers: Combined sewers, Minneapolis, Minn.

Details are given of a proposal to use storm water and water discharged from air-conditioning plants to maintain the levels in a chain of recreational lakes at Minneapolis, Minn., during the summer months. By constructing a control dam in the lower portion of the existing system of drainage tunnels, 2.6 mil. gal of water can be impounded. The dam will be fitted with a sluice gate which will permit periodic flushing of the system, and will open automatically during heavy rainfall. The air-conditioning water is of good quality, and precautions will be taken to avoid interconnexions between the tunnels and the city's combined sewerage system. It is estimated that, in spite of variations in flow, the design flow of 22 ft (3) per sec can be maintained during most of the 100-day period when it is intended to divert water to the lakes. W69-01502

#### REPORTS ON THE PROGRESS OF APPLIED CHEMISTRY.

For primary bibliographic entry see Field 05D. For abstract, see . W69-01505

## WATER POLLUTION RESEARCH, 1965.

Great Britain Ministry of Technology

London, H M Stationery Office, 1966. 224 p, 4

Descriptors: \*Storm runoff, Sewage treatment. Identifiers: Great Britain.

This report contains information on work carried out at the Water Pollution Research Laboratory during 1965, including investigations on the activated-sludge process and biological filtration; biological decomposition of synthetic detergents; role of protozoa in biological treatment processes; ecology of invertebrates in filters; sedimentation of sewage and humus; factors affecting digestion and dewatering of sludge; volume and composition of storm sewage; treatment of humus-tank effluent in pebble-bed clarifiers; recovery of water from sewage effluents; treatment and disposal of various types of trade waste water; effects of pollution on fish; oxygen balance in streams; control of water weeds and midges; growth of sewage fungus in streams; dispersion of sewage from sea outfalls; and development of analytical methods and instruments. A list of papers published during the year is appended. W69-01506

### WATER POLLUTION RESEARCH, 1964. Great Britain Ministry of Technology.

London, H M Stationery Office, 1965. 182 p.

Descriptors: Sedimentation, \*Storm runoff, \*Biochemical oxygen demand, \*Chemical analysis, Flow measurement. Identifiers: \*Suspended solids, \*Great Britain.

This report contains the results of investigations on the following subjects: (1) aerobic biological treatment of sewage and industrial wastes; (2) sedimentation processes; (3) sludge treatment; and (4) sewage. The data obtained on the flow and composition of storm sewage at Brighouse, Yorkshire have been analyzed. Although the B.O.D. and con-

## Field 05-WATER QUALITY MANAGEMENT AND PROTECTION

## Group 5G—Water Quality Control

centration of ammoniacal nitrogen in storm sewage were lower than the dry-weather values, the con-centration of suspended solids was always much higher. In general, the B.O.D., permanganate value, and ammonia content of the storm sewage discharged in the first 15 minutes were about twice as great as that discharged after the first 30-40 minutes; the reduction in suspended solids content was much less marked. W69-01507

RIVER **TECHNICAL** PROBLEMS OF AUTHORITIES AND SEWAGE DISPOSAL AUTHORITIES IN LAYING DOWN AND COM-PLYING WITH LIMITS OF QUALITY FOR EF-FLUENTS MORE RESTRICTIVE THAN THOSE OF THE ROYAL COMMISSION.

Ministry of Housing and Local Government, London, 1966, 20 pp.

Descriptors: \*Sewage effluents, \*Standards, Dissolved oxygen, \*Storm runoff, Sampling. Identifiers: \*Suspended solids, \*Great Britain.

This memorandum explains the circumstances under which sewage effluents should be required to reach a standard better than that recommended by the Royal Commission. In deciding the standards to be imposed under particular circumstances, consideration should be given to the probable concentration of dissolved oxygen in the effluent and the possible need for aeration; seasonal variations in requirements; and flows to be treated, including the proportion of storm sewage to be expected. The only standard considered justifiable for discharges of storm sewage is a condition limiting the content of suspended solids, and since this concentration is highly variable it is recommended that these effluents should not be required to conform to a given standard (e.g. 100 mg per liter) all the time, but provision should be made for one or two samples out of every ten, taken on different days, to exceed the limit. W69-01517

TRENDS IN FINANCIAL SUPPORT FOR WATER POLLUTION CONTROL, North Carolina Univ., Raleigh, N. C. Water

Resources Res. Inst.

David H. Howells.

ASCE Proc, J Sanit Eng Div, Vol 93, No SA3, pp 1-13, June 1967.

Descriptors: \*Water pollution control, Construction, \*Grants, \*Legislation.
Identifiers: \*Combined sewers.

The trend in Federal support of municipal wastetreatment construction is toward larger annual appropriations with higher levels of support for states providing matching funds. States should enact parallel grant-in-aid legislation to take full advantage of Federal aid in the future and maintain an influential position in water-pollution control Rapid movement toward financial assistance for industrial waste treatment is not anticipated unless the current study by the Secretary of the Interior should add to the momentum. Effluent charges are considered unlikely if industry responds favorably to its responsibilities for water-pollution control The Clean Waters Restoration Act of 1966 authorized 75% grants to public bodies for projects concerned with improved pollution control from combined sewers. W69-01526

# INTERPRETING THE 1951 RIVERS POLLU-TION PREVENTION ACT,

W. F. Lester.

Munic Eng Sanit Rec, Vol 131, pp 186-7, 1954.

Descriptors: Standards, Sewage effluents, \*Water pollution, \*Overflow, \*Storm runoff, \*Legislation. Identifiers: \*Rivers (Prevention of Pollution) Act

The author discusses the implementation of the Rivers (Prevention of Pollution) Act 1951. Details are given of the standards recommended by the Royal Comm. on Sewage Disposal for effluents discharged to surface waters and demands are made for more stringent standards. The problem of dealing with storm water overflows from sewage works or from separate sewerage systems is duscussed with reference to the work of the River Boards in making by-laws. W69-01527

### WATER POLLUTION CONTROL FEDERAL AID PROGRAMS.

Paul W. Reed

12th Annual Wastes Engng Conf, U of Minn, Minneapolis, Minn, Dec 10, 1965, 15 p.

Descriptors: \*Water pollution control, \*Construction, \*Grants, \*Legislation.

The FWPCA is described with special emphasis on the construction grant programs. Surveys of municipal waste treatment needs are described. The Water Quality Act of 1965 is outlined. Public Health Service studies on water pollution control are summarized as well as related Federal programs. W69-01529

#### CONSTRUCTION OF RETARDING BASINS FOR THE DRAINAGE OF MOTOR-

G. W. Annen

Gas-u WassFach, Vol 108, pp 46-48, 1967.

Descriptors: Runoff, \*Drainage, \*Highways, Pollution abatement. Identifiers: Retarding basins.

A detailed description is given of the design and operation of retarding basins, which have been installed along the newly-built motorway south of Dortmund, Germany. These basins are designed to slow down the run-off, separating mechanically the insoluble polluting substances, particularly oils, and thus protecting the receiving waters. W69-01532

# SANITARY SERVICES. GREAT ACHIEVE-MENTS FOR A PLAN OF WORKS.

Rev Obr sanit Nac, B Aires, Vol 42, pp 164-185, 1960.

Descriptors: \*Planning, \*Sewers. Identifiers: Storm sewers, \*Argentina.

After a review of legislation relating to the provision of water supplies and storm and sanitary sewerage systems in Argentina, brief descriptions are given of the facilities in operation, under construction, and planned, for more than a hundred different urban centers, each considered individually. A map is included showing the position of water supply and sewerage systems throughout the country. W69-01558

#### EFFECTS OF LAND USE ON WATER RESOURCES, W. E. Bullard.

J Water Poll Control Fed, Vol 38, pp 645-59, April 1966.

Descriptors: \*Land use, \*Water quality, Sedimentation, Nutrients, \*Water pollution, Runoff. Identifiers: \*Urban drainage.

Land use, among other factors, determines the quality of water produced. Erosion causes turbidity and sedimentation, lowers water quality, and damages aquatic life habitats. Fertilizers, pesticides, and other toxins and nutrients contribute to pollution. Agriculture, timber, mining, urban ru-noff, and recreation also are pollution contributors. W69-01564

## ECONOMIC SURFACE-WATER SEWERAGE: A SUGGESTED STANDARD OF PRACTICE, L. B. Escritt, and A. J. M. Young.

J Instn Publ Hlth Engrs, Vol 62, 1963

Descriptors: \*Design, \*Sewers, \*Storm runoff, Storms, Surface runoff. Identifiers: \*Surface permeability, \*Urban drainage.

In an examination of data, provided by the Road Research Laboratory, for use in the design of sewers, the authors question the conclusion that the amount by which calculated rates of runoff during storms exceed recorded rates is due to storage. They suggest that it is due to a change in impermeability of the catchment and describe an experiment, using a sheet of plate glass as a catchment, to support their views. The Lloyd-Davies method of calculation should be used, with the assumption that roofed and paved surfaces in developed areas have an impermeability of 80 per cent and not 100 per cent as the Road Research Laboratory suggests. W69-01569

### 06. WATER RESOURCES PLANNING

## 6A. Techniques **OF Planning**

## DISCUSSION OF AQUEDUCT CAPACITY UNDER AN OPTIMUM BENEFIT POLICY, Illinois Univ., Urbana For primary bibliographic entry see Field 04A.

For abstract, see W69-01206

### ECONOMIC CONTROL OF GROUNDWATER RESERVES.

Missouri Univ., Columbia. For primary bibliographic entry see Field 04B. For abstract, see . W69-01207

### PRODUCT-MIX ALTERNATIVES: CONTROL, ELECTRIC POWER, AND IRRIGA-TION,

Stanford Univ., Palo Alto, Calif. For primary bibliographic entry see Field 04A. For abstract, see . W69-01208

### USE OF STORAGE WATER IN A HYDROELECTRIC SYSTEM,

Massachusetts Institute of Technology, Cambridge. For primary bibliographic entry see Field 04A. For abstract, see. W69-01209

# STATISTICAL ANALYSIS OF THE RESERVOIR STORAGE - YIELD RELATION.

Harvard Univ., Cambridge, Mass., Harvard Water Resources Group.

In Operations Research in Water Quality Management, pp 1-1 to 1-21, Feb 15, 1963. 5 fig, 3 tab, 11

Descriptors: Computer models, Correlation analysis, Distribution patterns, Evaluation, Hydrologic \*Reservoir design, Reservoir operation, stical methods, Regression analysis, \*Statistical methods, Regression analysis, \*Synthetic hydrology, Water management (Applied), Water quality control.

Identifiers: \*Storage-yield relation, Serial correla-

A discussion of the development of synthetic hydrology was presented. The objective was the efficient application of statistical techniques to available hydrologic data for reservoir planning and operation. Results of a computer study indicat-

### Techniques of Planning—Group 6A

ing the level of reliability of storage estimates based on masstdiagram calculations were given. A variety of statistical populations of streamflow were investigated together with a range of annual drafts. The reliability of conventional storage estimates made from streamflow records of the usual length was shown to be low. The storage required to meet any given yield was then treated as a statistical variate whose distribution has the same first three moments as the observed streamflows. Given the distribution, or its moments, the specification of storage was treated as a problem in decision making under risk. The statistical technique was found to be superior to the conventional method. One of seven chapters in 'Operations Research in Water Quality Management'. (Gysi-Cornell) W69-01210

A METHOD OF OPTIMIZING DESIGN OF WATER QUALITY MANAGEMENT SYSTEMS. Harvard Univ., Cambridge, Mass., Harvard Water Resources Group.

In Operations Research in Water Quality Management, pp 6-1 to 6-14, Feb 15, 1963. 22 p, 7 fig, 3

Descriptors: Operations research, Computer programs, Comparative benefits, \*Analytical techniques, \*Design, Optimization, \*Simulation analysis, Water quality, \*Water management (Ap-

Identifiers: \*Method of steepest ascent, Local optimum, Response surface.

The 'method of steepest ascent' was presented as a technique for finding the optimal design of a water management system, and was applied to an illustrative problem of a settling tank design. The technique was developed and adapted to machine computation. The computer evaluated the system at a starting point chosen by a random sampling technique, corresponding to a particular set of assigned values of the decision variables (design dimensions). It determined the gain in economic efficiency resulting from a small increment applied to each variable, and computed the combination of increments that caused the most rapid increase in net benefits. The subroutine which checked the continual progress of the decision variables toward their local optimum values was shown in a flow diagram. A comparison of a hand computation and a machine computation of the problem were given. One of seven chapters in 'Operations Research in Water Quality Management'. (Gysi-Cornell) W69-01211

#### APPLICATION OF DECISION THEORY TO ENGINEERING SANITARY DESIGN PROBLEMS.

Harvard Univ., Cambridge, Mass., Harvard Water Resources Group.

In Operations Research in Water Quality Management, pp 4-1 to 4-16, Feb 15, 1963. 24 p, 8 fig, 13

Descriptors: Operations research, Computer programs, \*Decision making, Distribution patterns, Discount rate, Economic efficiency, Mathematical models, Data collections, Estimating equations, Probability, Septic tanks, \*Statistical methods, \*Sanitary engineering, \*Design, Water quality con-

Identifiers: \*Statistical decision theory, Adsorption fields, Economic horizon.

A mathematical model employing statistical decision theory was developed to aid in the planning of complex systems. The model used matrix algebra and response surface sampling, and featured a method for reaching decisions under risk. It was applied to the problem of sewage disposal in un-sewered subdivisions. The objectives were: (1) to develop a formulation and computational routine for determining the optimal balance of septic tanks and absorption fields at each site; (2) to develop criteria for indicating the proper number and kind of tests in each subdivision, and the proper interpretation of the tests regarding adsorption field capacities; and (3) to indicate if additional data on soil characteristics was needed or economically justified. The model evaluated the costs of making incorrect decisions and of having only uncertain information. The model considered economic parameters such as discount rates and time horizons, and included financing and administra-tive costs. One of seven chapters in 'Operations Research in Water Quality Management'. (Gysi-W69-01212

#### MATHEMATICAL MODEL FOR DETERMIN-ING THE OPTIMAL SIZES OF WATER TREAT-MENT PLANTS

Harvard Univ., Cambridge, Mass., Harvard Water Resources Group

In Oper Res in Water Quality Management, pp 5-1 to 5-21, Feb 15, 1963. 28 p, 9 fig, 8 tab, 10 ref.

Descriptors: Operations research, \*Decision making, Discount rate, Hydraulic design, Future planning (Projected), \*Municipal water, \*Mathematical models, \*Optimal development plans, Project life, \*Statistical methods, Water demand, Water treatment, Economies of scale.

Identifiers: \*Decision theory, Present value, Loss function.

A decision theory model was presented which indicated the proper size of a water treatment plant to be developed. The problem required the balancing of economies of scale in present construction against the diseconomy of unprofitable investment in excess capacity not needed for several years. The plant size that maximized economic efficiency was expressed as a function of population growth rate, per capita demand for water, the interest rate of capital investment, and the economic time horizon. Municipal water requirements were not treated as rigid constraints. Instead, a loss function which assigned economic penalties to small or medium sized water shortages was used. A hypothetical example illustrated the use of the model. One of seven chapters in 'Operations Research in Water Quality Management'. (Gysi-Cornell) W69-01213

### OPTIMAL TIMING OF IRRIGATION.

California Univ., Riverside; Nevada Univ., Reno. Warren A. Hall, and William S. Butcher Amer Soc Civil Eng Proc, Vol 94, No 1R2, pp 267-275, June 1968. 3 ref, 2 append.

Descriptors: Estimated benefits, Estimated costs, Economic efficiency, Irrigation, \*Irrigation efficiency, Irrigation programs, \*Dynamic programming, Digital computers, Optimization, Seasonal, \*Water management (Applied), Water distribution (Applied), Wilting point, \*Water shortage, \*Crop production.

A dynamic programming model was presented which determined the time and quantity of irrigation which maximized the total net returns from a crop. The state variables for the model were the soil moisture content and quantity of water available in each of the subdivided time periods considered for the growing season. The decision variable was the quantity of water used in each period. It was assumed that a coefficient which is a function of the soil moisture could be found that would give the percent of maximum yield of the crop for each period. The objective was to maximize the product of these coefficients times the maximum yield. Constraints for the model were physical (e.g., (1) amount of water available at the beginning of the season, (2) wilting point and field capacity for the soil moisture). An inventory constraint provided continuity between periods for the soil moisture. It was concluded that the methodology described could permit good irrigation management, provided more information became available on the critical period characteristics of commercial crops. (Gysi-Cornell) W69-01214

SOCIALLY OPTIMUM PRICING POLICY FOR A PUBLIC WATER AGENCY,

Washington Univ., Seattle; California Univ., Berkeley

Gardiner Brown, Jr., and C. B. McGuire. Water Resources Res, Vol 3, No 1, pp 33-43, 1st Quart 1967. 5 tab, 12 ref.

Descriptors: \*Linear programming, Aquifers, Computer models, \*Conjunctive use, Discount rate, Water allocation (Policy), \*Water distribution (Applied), Water demand, Fixed costs, Variable costs, \*Economic efficiency, Estimated benefits, Marginal costs, Public benefits, Social values

Identifiers: Kern County Water Agency (Calif), Demand function, Pumping tax, Lagrange multipli-

A model was developed for determining the socially optimum price to charge irrigation districts for both surface and groundwater supplies. An algorithm was developed assuming linear demand functions, and steady-state conditions for ground-water levels and water demand functions. A divergence between social and private optimums arose from the existence of unadjudicated rights to groundwater supplies. The social optimum was achieved by a taxing policy which equated the farmers' marginal private costs to the true marginal social cost. Hence, the farmers' profit maximization motivation yielded the desired social optimum. An example of the model was given for the Kern County Water Agency (California). Water prices, tax rates, and optimum lift levels were estimated for seven irrigation districts within the jurisdiction of the agency. (Gysi-Cornell) W69-01215

### OPTIMAL RESOURCE USE OVER TIME WITH AN APPLICATION TO GROUND WATER,

California Univ., Davis, California.

Oscar R Burt

Manage Sci, Vol 11A, pp 80-93, Sept 1964. 10 ref, 2 append.

Descriptors: \*Dynamic programming, Aquifers, \*Economic efficiency, Pumping, \*Groundwater mining, Marginal productivity, Marginal costs, Synthetic hydrology, Water balance, Water allocation (Policy), \*Water management, Optimum development plans, Consumptive use. Identifiers: Kings River (Calif).

The problem of optimally allocating over time a fixed or only partially renewable resource was solved using dynamic programming. First and second degree approximations to the functional equation were used to solve the problem. Differentiation of the functional equation with respect to the resource level and its periodic use in order to maximize the expected net output yielded approximate decision rules for resource use. These decision rules were a function of current supply and interest rate. The results were applied to ground water storage control and tested empirically, using data from a study on the Kings River area in California. The results compared favorably with a decision rule obtained by detailed numerical methods. Additions to the resource were treated as random variables with probability distributions reflecting the type of resource and its method of recovery. The decision rules in general specified, as expected, that production should be expanded until marginal net output equals marginal recovery costs. (Gysi-Cornell) W69-01216

## THE OPTIMUM ALLOCATION OF STREAM

DISSOLVED OXYGEN, Johns Hopkins Univ., Baltimore, Md.; Cornell Univ., Ithaca, N. Y. Jon C. Liebman, and Walter R. Lynn.

## Group 6A—Techniques of Planning

Water Resources Res, Vol 2, No 3, pp 581-591, 3rd Quart 1966. 11 p, 5 fig, 5 tab, 11 ref

Descriptors: Biochemical oxygen demand, Design criteria, Digital computers, \*Dissolved oxygen, \*Dynamic programming, Economic efficiency, Sewage effluents, Oxygen sag, \*Sewage treatment, \*Standards, Waste assimilative capacity, \*Stream improvement, Water policy, Water quality control. Identifiers: Willamette River (Oregon), Uniform

A discrete dynamic programming model was used to minimize the cost of providing waste treatment to meet specified dissolved oxygen concentration standards in a stream. The model was developed from the Streeter-Phelps equation which relates dissolved oxygen to waste loading. It was assumed that the saturation level varied linearly within a reach. Choosing discrete values for water quality at the top of the reach, the costs of obtaining various levels of dissolved oxygen in successive downstream sections were computed by the recursive calculations of dynamic programming. A simplified example of the model based on data from the Willamette River in Oregon was solved and the results presented in tabular form. Three runs were made, one which met required stream standards, a second with the standards lowered by 0.1 mg/1 in all sections, and a third in which all plants treated at the same rate. The total cost of equal treatment was substantially more than the minimum cost of meeting the stream standards. (Gysi-Cornell) W69-01217

### FORMAL MODELS IN THE DESIGN OF WATER RESOURCE SYSTEMS,

Harvard Univ., Cambridge, Mass.

Robert Dorfman. Water Resources Res, Vol 1, No 3, pp 329-336, July-Sept 1965. 5 ref.

Descriptors: \*Analytical techniques, \*Digital computers, Design, Economic efficiency, Environmental engineering, Linear programming, \*Mathemati-cal models, Monte Carlo Method, Queuing theory, Water resources development, \*Simulation analysis, Systems analysis, \*Water resources

The use of simulation and analytic models in the design of water resource systems was discussed. A brief history of the evolution of these methods beginning with The Harvard Water Resources Program was given. A comparison of simulation techniques, where temporal sequences of events are reproduced on electronic computers reducing the time scale from decades to minutes, was made to analytic techniques, where consequences are expressed as explicit mathematical functions of design variables. The simulation model leads to convenient estimates of the consequences of design decisions even in complicated circumstances, but are awkward when a wide range of these decisions has to be evaluated. On the other hand, analytic models cannot be applied to practical problems without drastically simplifying them. It was suggested that the two methods can be used in tandem, with analytic models delimiting the range within which simulation is required. (Gysi-Cornell)

### WATER QUALITY IMPROVEMENT PRO-GRAMMING PROBLEMS,

Stanford Univ., and Stanford Research Institute, Stanford, Calif. Matthew J. Sobel.

Water Resources Res, Vol 1, No 4, pp 477-487, 4th Quart 1965. 11 p, 12 ref, 1 append.

Descriptors: \*Dissolved oxygen, \*Standards, Estuaries, Public benefits, Indirect benefits, Direct benefits, \*Linear programming, Mathematical models, Optimization, Project planning, Constraints, Social values, Sewage treatment, Diffusion, Waste dilution, \*Waste water treatment, Water policy, \*Water quality control, Water values.

Identifiers: Delaware Estuary, Delaware River Basin Commission, Mixed integer linear programming.

The nature of regional water quality systems was outlined and programming models for several water quality improvement problems were presented. A linear programming formulation of a static or one-shot improvement in water quality at minimum cost was contrasted with a traditional uniform treatment policy for programming improvements. The constraints for the linear programming formulation were used throughout the remainder of the paper. The traditional policy resulted in a mixed integer problem. The maximization of the ratio of benefits to costs of an improvement program were transformed to a linear programming problem. An expected value formulation of the minimum cost improvement problem under a stochastic environment was given, followed by the quadratic programming problem of minimizing the variance of an improvement program. An application of least-cost models to a water quality improvement program for the Delaware estuary was discussed. The mixed integer linear programming problem was detailed in an appendix. (Gysi-Cornell) W69-01219

#### TEMPORAL ALLOCATION OF GROUND-WATER.

Missouri Univ., Columbia.

Oscar R. Burt.

Water Resources Res, Vol 3, No 1, pp 45-56, 1st Quart 1967. 3 fig, 1 tab, 5 ref, 1 append.

Descriptors: \*Water management (Applied), Temporal distribution, Surface-ground water relationships, Aquifers, Consumptive use, Dynamic programming, \*Economic efficiency, \*Future planning (Projected), Pumping, \*Groundwater recharge, \*Groundwater mining, Marginal produc-

Identifiers: Decision rule, Present value, San Joaquin Valley (Calif).

A relatively simple economic model for allocation of groundwater either to storage or to immediate pumping was developed. Equilibrium storage was first assumed (constant recharge equalling constant rate of use) and the economic consequences of altering various parameters in the model with respect to the effect on these equilibrium stocks and rates of use were found. The assumption of constant recharge was then relaxed and the concept of a conditional decision rule for stochastic groundwater recharge and the properties of the implied equilibrium were discussed. A hypothetical example was given using estimated pumping costs for the San Joaquin Valley. In its simplest form, the derived decision rule was to equate marginal net output with respect to rate of use to capitalized marginal net output with respect to water stocks. The appendix outlined a procedure for estimation of the value of groundwater stocks as a contingency against uncertain future supplies. (Gysi-Cornell)

### HISTORY AND SIGNIFICANCE OF SIMULA-TION MODELS,

Oregon State Univ., Corvallis. Louis N. Stone.

The Use of Simulation in Water Research, Semn WR 006.67, pp 1-15, Jan 1967. 9 ref.

Descriptors: \*Simulation analysis, Computer models, Analog computers, Analog models, History, Model studies, Systems analysis.

A presentation of the use of models, with emphasis on simulation, was given. Simulation was defined. Models in general were classified and discussed. Classifications included deterministic, stochastic, predictive, normative, gaming, linear programming, and system models. Some historical classical models were described, including resistance, electric circuit, electrolytic tank, nonlinear resistor, and gravitational models. Several illustrative examples of simulation models were given. They included an atmosphere-soil boundary model, an underground water flow model, a flood simulation model, an acoustic ray model, a biochemical systems model, and a 'conditioned response' model. Three simulation programs, called PACTOLUS, MIDAS and DYNAMO, developed for use on digital computers, were mentioned. (Gysi-Cornell) W69-01221

## THE OPTIMIZATION OF SINGLE-PURPOSE RESERVOIR DESIGN WITH THE APPLICATION OF DYNAMIC PROGRAMMING TO SYNTHETIC HYDROLOGY SAMPLES,

California Univ., Los Angeles. Warren A. Hall, and David T. Howell. J Hydrol, Vol 1, pp 355-363, Dec 1963. 12 ref.

Descriptors: \*Dynamic programming, \*Synthetic hydrology, \*Reservoir design, \*Optimization, Consumptive use, Monte Carlo method, Monetary benefits, Return (Monetary), Correlation analysis, Risks, Water demand, Water policy, Simulation analysis, Hydrograph analysis. Identifiers: Operating policy.

A method was developed for determining the optimal size of a single-purpose reservoir on a stream with serially correlated annual flows, in order to provide storage for consumptive use. The operating policy on an annual basis was obtained as a consequence of the analysis. The procedure combined dynamic programming sequenced over time, where each time interval could have a different return function, with a Monte Carlo technique using a number of equally likely sample sequences of inflow drawn randomly from a long synthetically generated period of record. The analysis gave an optimum operating policy, the expected value of the optimal return and the degree of risk involved which arises from the hydrologic characteristics of the stream. (Gysi-Cornell) W69-01222

# PLANNING RATIONAL WATER POLLUTION CONTROL POLICIES, Cornell Univ., Ithaca, N. Y.

Daniel P. Loucks.

Proc Int Conf Water For Peace, Pap No P/397, Washington D C, May 1967. 8 ref.

Descriptors: \*Water pollution control, \*Systems analysis, Computer programs, Optimization, Economics, Operations research, \*Planning, \*Water policy, \*Standards, Water quality control, Stream improvement, Stochastic processes, Risks, Evaluation, Probability. Identifiers: Sensitivity analysis.

The use of systems analysis techniques in the planning and evaluation of water pollution control policies is discussed. Water pollution is defined, and present methods for defining pollution control policies are described. The techniques of systems analysis and operations research, such as the mathematics of optimization, economic theory, probability theory and computer programming, used for the establishment, improvement, and sensitivity analysis of stream quality standards and design criteria, are examined. The importance of sensitivity analysis in the establishment of rational policies is stressed. The need for basing policies on the minimization of risk of violating quality standards, because of the stochastic nature of streamflows, rather than on deterministic standards, is discussed. Additional research areas are suggested. (Gysi-Cornell) W69-01223

### THE ECONOMICS OF CONJUNCTIVE USE OF GROUND AND SURFACE WATER,

California Univ., Davis. For primary bibliographic entry see Field 06B. For abstract, see W69-01224

### Evaluation Process—Group 6B

PRELIMINARY OPTIMIZATION OF AN AQUEDUCT ROUTE, Calif. Univ., Los Angeles; The National Cash Re-

gister Co., Hawthorne, Calif. Warren A. Hall, and John S. Hammond, III.

Amer Soc Civil Eng Proc, Vol 91, No IR1, pp 45-67, Mar 1965. 23 p, 13 fig, 19 ref, 2 append.

Descriptors: \*Dynamic programming, \*Aqueducts, Terrain analysis, Network design, Water conveyance, Construction costs, Electrical power costs, Fixed costs, Variable costs, Hydraulic gradient, \*Economic efficiency, Optimum development plans, Engineers estimates, Surfaces, Marginal benefits.

Identifiers: Lift and reach, Least cost routes, Network analysis.

The preliminary routing of an aqueduct was structured as a network problem. Dynamic programming was used to choose the most economical route from a variety of potential routes. The general problem was divided into three subproblems: (1) the subdivision of the general route area into polyhedron surfaces in order to locate the nodes of the network, (2) lift and reach cost calcuations in order to find the minimum link costs, and (3) finally determining the most economic routes connecting any two points in the network. The first two subproblems were discussed in greater detail than the third. Several references were suggested for further study on finding the most economic routes through a network. The optimal path across a plane was shown to be one 'lift' and one or at most two 'reaches.' A numerical example using hypothetical data was presented. Some extensions of the model were proposed for further investigation. (Gysi-Cornell) W69-01225

PROBLEMS IN DEVISING PROCEDURES FOR APPROXIMATING OPTIMUM SYSTEMS.

op 86-95 of Entry No. W69-01269 in 05G.

Descriptors: Water pollution, Pollution abatement, \*Water pollution control, Cost analysis, Economics, \*Model studies, \*Optimization, Regional analysis, Systems analysis, Approximation method, \*Optimum development plans, Computer programs, Simulation analysis, Input-output analysis, Sequence, Timing, Operations research, Computer models, Project planning, Cost comparisons.

Problems in devising procedures for approximating optimum systems are discussed. Possible alternatives are discussed with respect to a cost minimization objective. Possible use of simulation and programming as aids in planning are noted. Abatement measures and related costs are viewed as inputs and reduction of pollution as the output. The problems of timing and sequence are viewed. It is concluded that the application of operations research echniques merits attention; however, the complexty of such analysis is noted. W69-01275

HYDROLOGICAL STUDY OF THE LATTON GROUND-WATER SOURCE,

Swindon Corp Water Department, Swindon, Wilts, Great Britain.

For primary bibliographic entry see Field 02F.

For abstract, see . W69-01410

CONTRIBUTION TO THE OPTIMIZATION OF SYSTEM OPERATION BY THE CHOICE OF SUITABLE METHODS OF CALCULATION FOR FRANSIENT STABILITY, Dresden Technical Univ, Germany.

For primary bibliographic entry see Field 08C.

For abstract, see . W69-01414

HYDRAULIC MODEL OF RUNOFF FROM DEPRESSIONAL AREAS,

Kentucky Univ., Lexington; Iowa State Univ.,

Ames.
C. T. Haan, and H. P. Johnson.
Trans Amer Soc Agr Eng, Vol 11, No 3, pp 364-373, May-June 1968. 10 p, 18 fig, 18 ref, append.

Descriptors: \*Hydraulic models, \*Runoff, \*Surface runoff, Mathematical analysis, \*Watersheds, Drainage basins, Subsurface drains, Hydrographs, Runoff forecasting, Hydrology, Rainfall, Bibliographies, Atmospheric precipitation, Ditches. Identifiers: \*Hydrologic models, Iowa, \*Potholes, \*Depression storage, Mathematical models, Subsurface drainage, Runoff hydrographs.

Hydraulics of runoff from depressional areas in north-central lowa were studied. Definable relationships existed among the geometrical properties of depressions; the frequency distribution of depressional areas can be approximated by a Weibull probability density function. From synthesized mathematical model watersheds, an area of a few square miles had depressions storing more than 1/2 in. of surface runoff. Another mathematical model was developed, capable of simulating runoff hydraulics appearing in drainage ditches less than 48 hr after rainfall. The model had several components, each based on a rational analsis of the process that the component represents. This is a valid method for studying runoff from depressional areas and for investigating the effect of subsurface drainage on peak flows. The effect of changing the values of several variables on runoff hydrographs was investigated. Resulting changes in the hydrographs were on a qualitative basis from a rational analysis of the problem. This indicates that the components of the model represent their respective individual counterparts of the runoff cycle, rather than combining to give a hydrograph that best fits observed data. (USBR) W69-01436

A DYNAMIC SIMULATION OF THE LOWER

KANSAS RIVER DRAINAGE SYSTEM, Federal Water Pollution Control Administration, Atlanta, Ga; University of Kansas, Lawrence For primary bibliographic entry see Field 02E. For abstract, see. W69-01468

### **6B. Evaluation Process**

THE ECONOMICS OF CONJUNCTIVE USE OF GROUND AND SURFACE WATER,

California Univ., Davis.

Oscar R. Burt.

Hilgardia, Vol 36, No 2, pp 31-111, Dec 1964. 81 p, 2 fig, 49 tab, 56 ref, 4 append.

Descriptors: \*Conjunctive use, \*Dynamic programming, \*Linear programming, \*Economic efficiency, \*Water management, Aquifers, Markov processes, Distribution patterns, Discount rate, Marginal productivity, Water balance, Ground-water recharge, Hydrologic data, Surface-groundwater relationships.
Identifiers: Kings River (Calif), Pine Flat Reservoir

(Calif), Present value.

The economics of water resources was discussed with special emphasis on the optimal management of water in existing storage and distribution facilities. Dynamic programming was used to determine the optimal conjunctive use of single and multiple storage facilities. An alternative, requiring only a small computer and simple program, but confident prediction of streamflows, was given. Linear programming was used to estimate the net social benefits and the net output function. A detailed description was given of activity demand functions and the environmental constraints. Surface water policy and the probability distribution and transition probabilities for ground water storage were discussed. Numerical examples were presented with data obtained from a study of the Kings River, Pine Flat Reservoir, California. The empirical results considered present, marginal, and expected values of management policies and the Markovian properties of stochastic hydrology. (Gysi-Cornell) W69-01224

FEDERAL RESEARCH AND DEVELOPMENT PROGRAMS: DECISION MAKING PROCESS CONVERSION OF DEFENSE RESOURCES WITH EMPHASIS ON EXPANDED PROGRAMS OF URBAN DEVELOPMENT, MASS TRANS-PORTATION, AND WATER RESOURCE DEVELOPMENT.

Cornell Univ., Ithaca, N. Y.

Hearings, House Comm on Government Operations, Subcomm on Research and Technical Programs, 89th Cong, 2nd Sess, pp 177-212, 1966. 36 p, 3 append. OWRR Project A-005-NY.

Descriptors: \*Diversification, \*Water development, Water resources, \*Transportation, \*Urban renewal, Area development, Questionnaires, Community development, \*Industries. Identifiers: \*Defense industries, Cornell U (NY).

This is a report of a study carried out at the School of Industrial and Labor Relations at Cornell University. The research involved collecting facts, investigating attitudes, and analyzing the interactions of groups of people as they attempted to deal with a common problem. Specifically, the purpose was: (1) to determine the extent to which some leading defense contractors are trying to diversify, thereby reducing their dependence on defense business; (2) to identify major obstacles standing in the way of business firms converting some of their resources from defense to nondefense activities; (3) to explore the interest of defense companies in entering the market for expanded programs of water resource development, mass transportation, and urban development; and (4) to examine the potentiality of greater industry and government cooperation in expanded programs of water resources development, mass transportation, and urban development. W69-01226

WATER RESOURCES RESEARCH AND EDU-CATIONAL NEEDS IN MINNESOTA.

Minnesota University, Minneapolis

Water Resour Res Center Bull 5, Univ Minnesota, Mar 1967. 120 p, 43 fig, 18 tab, 48 ref. OWRR Project A-999-Minn.

Descriptors: \*Water resources development, \*Resource development, Water pollution, Water supply, Water resources, Recreation, \*Education, Water law, Economics, Priorities, Natural resources, Planning, Water quality, Water pollu-tion control, Floods, Minnesota, Economic impact, \*Research and development.

Identifiers: Water budget, Water level, Water resources management.

This bulletin is a collection of papers presented at a Conference on Water Resources Research Needs in Minnesota held on November 15-16, 1966 in St. Paul. Results of a questionnaire concerning research need priorities are summarized. Subjects covered in these papers are research needs, water supply, water pollution, floods, land and water, water-based recreation, economic aspects and education in water resources.

STRATEGIES FOR WESTERN REGIONAL WATER DEVELOPMENT,

California University, Berkeley.

Ernest A. Engelbert.
Proc, Western Interstate Water Conf, Corvallis, Oreg, 1965, 195 p.

Descriptors: \*Water resources development, Watershed management, Water pollution, Water

## Field 06-WATER RESOURCES PLANNING

### **Group 6B—Evaluation Process**

conservation, Water quality, Water utilization, River basin development, Cooperation, Water rights, Policy matters, Weather modification, rights, Policy matters, Weather modification, Feasibility studies, Evaluation, Economics, Benefits, Water harvesting, \*Water management Benefits, V (Applied).

Identifiers: Water shortages, Western United

Few if any issues are more crucial for the future development of Western states than effective use and management of the region's water resources. Unprecedented population and economic growth during the post war period has resulted in unanticipated water needs and demands. Every state in West is presently faced with dangerously declining groundwater tables, serious stream pollution, socially disrupting conflicts among water users, and in some communities, critical shortages. Western water development involves many disciplines and facets of knowledge. The range of subject matter is reflected by the contributors to this volume who come from many fields of training and specialization, including the research, policymaking and managerial phases of water use. Their combined talents notwithstanding, the contributors would not claim that their collective papers cover all aspects of this topic. This work is viewed as an introduction for the citizen to a complex field of public and private decision-making W69-01244

#### CRITERIA FOR EVALUATING THE QUALITY OF WATER BASED RECREATION FACILI-TIES,

North Carolina University, Chapel Hill.

Charles Stott.

Water Resour Res Inst, Univ N Car, Rep 1, 1967. 88 p, 36 photo, 55 ref, 3 append. OWRR Project A-011-NC.

Descriptors: Bibliographies, \*Recreation facilities, Recreation, Swimming, Boating, Water sports, Locations, \*Evaluation, Design, Field tests, Construction, Maintenance, Safety.

Identifiers: Parking facilities, \*Criteria, Selection, Quality levels.

This study is limited to establishing criteria for day use facilities, roads, parking areas, picnic areas, swimming areas and boating areas. The criteria for each of these facilities is further divided into site selection, design, and construction, and state of maintenance and appearance. Many factors affecting quality were listed, checked with professional practitioners, and refined many times, then changed into criteria in the form of questions, followed by an interpretations. The criteria were pretested, refined and tested again in the field. The rating scale for evaluation criteria is given. W69-01250

#### **ECONOMICS** INTERDISCIPLINARY WATER RESOURCES ANALYSIS,

Rutgers -- The State University, N J.

Ruigers—The State Chirchard, To William Whipple, Jr. Pap, Amer Water Resour Ass, San Francisco, Calif, Nov 1967. 14 p, 13 ref. OWRR Project A-014-NJ.

Descriptors: \*Economics, \*Water resources, Analysis, Planning, Taxes, Project planning, Multiple purpose projects, \*Optimum development plans, Flood control, Social values, Hydroelectric power, Pollution abatement.

The report outlines some central issues of water resources planning and policy that require economic solutions. The author feels that the economist should assume the key role, although others should assist him in defining the problem and supplying certain parameters. He recommends econometrics and the interdisciplinary approach. W69-01254

### PLANNING FLOOD CONTROL MEASURES BY DIGITAL COMPUTER,

University of Kentucky, Lexington.

For primary bibliographic entry see Field 04A. For abstract, see . W69-01268

### WATER POLLUTION - ECONOMIC ASPECTS AND RESEARCH NEEDS.

For primary bibliographic entry see Field 05G. For abstract, see W69-01269

### ECONOMIC EFFICIENCY, SOCIAL POLICY, AND THE POLLUTION PROBLEM.

pp 18-28 of Entry No. W69-01269 in 05G.

Descriptors: Impaired water quality, Water pollution, \*Water pollution effects, Comparative costs, Economic efficiency, Economic evaluation, \*Economic impact, Economics, Efficiencies, Incosts, \*Welfare Public benefits, direct (Economics), Political aspects, \*Social aspects, Social impact, Social values, Model studies, Public health, Social needs, Benefits.

The ways in which unregulated market results with respect to water pollution fail to coincide with the requirements of an ideally functioning market system are discussed. Some of the directions that appropriate public policy might take are illustrated through the use of a hypothetical basin-wide firm, which recognizes that pollution causes technological links between various activities. It is pointed out that interdependency in consumption and conditions of supply do not yield appropriate social valuations in regard to some aspects of water quality. Political valuations become significant in these instances. It is concluded that none of these considerations negate the rationale of a competitive market system, but rather grow out of such a system. W69-01271

## EVALUATION-DETERMINATION AND IN-TEGRATION OF INDIVIDUAL AND SOCIAL VALUES--FOCUS OF PUBLIC POLICY, pp 29-45 of Entry No. W69-01269 in 05G.

Descriptors: \*Design flow, Political aspects, Public benefits, Social aspects, \*Social values, Water policy, \*Water pollution control, Water resources development, Public health, Pollution abatement, Water pollution, Water pollution effects, Governments, River basin development, Optimum development plans, Specialization, Economic impact.

The social objective of waste water disposal policy and the role of public policy in pollution abatement are considered. Stream specialization techniques are discussed with emphasis on the advantages of specialization and methods of evaluation. The design flow, a general problem in evaluation is discussed in detail. It is concluded that government intervention into the area of disposal of wastes into water bodies cannot only improve efficiency measured in terms of market values, but can and should take explicit cognizance of extra-market values and considerations. It is noted that system planning would ideally consider all alternative uses, but that the inherent complexity of the problem along with conceptual and informational deficiencies make optimum solutions virtually unattainable. A recommended approach is to set out basin-wide pollution control problems in formal terms. It is concluded that considerable research into various areas is essential. Benefit-cost analysis and property values are discussed in appendices. W69-01272

## AN ACT TO CREATE THE SOUTH CAROLINA WATER RESOURCES PLANNING AND COORDINATING COMMITTEE, AND TO PROVIDE FOR ITS DUTIES AND RESPONSIBILITIES. South Carolina Laws no 61 (1967).

Descriptors: \*South Carolina, Legislation, \*Administrative agencies, \*Water resources develop-ment, Water supply, Water quality, Water pollution, Political aspects, Navigation, \*Long-term planning. Identifiers: Water agencies.

The South Carolina Water Resources Committee is created. It is to have eighteen members and their method of appointment and terms are provided. An executive director and staff are to be hired. The committee is to advise the governor and general assembly in: (1) establishing a coordinated and comprehensive state water resources policy; (2) coping with special rural and urban water problems; (3) coordinating state agencies; (4) participating in federal programs; (5) protecting the interests of all groups in representation on interstate water agencies; (6) recommending law revision; and other functions as may be designated by the governor and general assembly. The committee is authorized to carry on studies, hold hearings and to contract with any agency. In connection with its recommendations, the committee is directed to consult with other state agencies, federal, state and local governments, and appoint advisory boards. Considerations such as adequate water supply, water quality, navigation, and watershed management, are to be taken into account by the Committee. (R. Williams-Fla) W69-01337

### THE RELATION OF WATER QUALITY TO WATER USERS,

Resources for the Future, Inc. For primary bibliographic entry see Field 05C. For abstract, see . W69-01400

### WATER QUALITY AND RESOURCES ALLO-CATION BY PRIVATE MARKETS, Resources for the Future, Inc.

Allen V. Kneese, and Blair T. Bower. In Managing Water Quality: Economics, Technolo-Institution, Baltimore: Johns Hopkins Press, 1968, Chap. 5, p 75-96, 2 fig, 18 ref.

Descriptors: \*Legal aspects, Optimum development plans, Waste discharge, Water quality, \*Market value, \*Economic justification, Project planning, Costs, Economies of scale, \*Water quality management, Judicial decision, Social values, Regional analysis, Regional development, Decision making, Institutional constraints.

Identifiers: Technological external diseconomies, Externalities, Decentralized decision making.

To realize the advantages of decentralized decision-making mechanisms ways must be found to optimally control external effects and direct interdependencies. Technological external diseconomies are illustrated by such problems as air pollution and water pollution. The failure of municipal and industrial waste dischargers to consider that subsequent water uses may be made more expensive or foreclosed entirely by their discharge, is perhaps the basic element of the water quality problem. Examples of how an optimal situation can be achieved through the market is presented. For each level of waste withheld from discharge there is an optimum combination of waste withholding measure which is in turn associated with a certain cost. Although it is possible for market transactions to take externalities into account under certain circumstances, transactions of this kind are rarely organized. The damaging effects of waste discharge are diffuse and the linkages between parties complex, so that establishing a market which would systematically take account of external costs would be a complex and expensive procedure. Efforts to use litigation to balance costs and returns suffer from the same disabilities as market transactions Six deficiencies of legal remedies are discussed Four suggestions for properly structuring the ju-diciary to play a useful and essential supplementary role are given. A detailed discussion of the possibility of internalizing the externalities of production through a basin-wide firm are presented. (Gargola-Chicago) W69-01401

### THE GALVESTON WORK PLAN,

Department of the Interior, Federal Water Pollution Control Administration, and Texas Water Pollution Control Board.

Dan M. Wells, Ernest T. Smerdon, and Earnest F. Glovna.

Texas Technological College, Texas A and M University, and the University of Texas, 1966, 10 p, 4 fig, 11 append.

Descriptors: Water resource development, \*Project planning, \*Optimum development plans, Water quality, Economic evaluation, Public benefits, Land use, Municipal water supply, Waste water treatment, Water law, Sedimentation, Phytoplankton, Administrative decisions, Institutional constraints, Models, Financing.

Identifiers: Galveston Bay, Texas, Recreation

The work plan was designed to develop a comprehensive study of the Galveston Bay area which would provide a sound water quality management plan. The work proposed is divided into four functional categories of projects. The first functional category is concerned with the evaluation of costs of making incremental improvements in water quality for both present and future conditions and for a variety of treatment programs. The second category attempts to evaluate the social benefits associated with improvements in water quality. The evaluation of the benefits to marine life associated with incremental improvements in water quality is the third functional category. The fourth category uses results obtained in the first three along with legal research and mathematical modeling techniques to determine the optimum feasible water quality management program. Estimates of the budget are presented and the necessary or-ganizational structure outlined. The organization would include a (1) policy making group, (2) project manager, (3) technical advisory group, (4) specialist in budget control and contracting, (5) specialists in water quality management, marine biology and ecology, land use planning, economics, and recreation, and optimization and computer applications, and (5) task forces for coordinated attack on problems. A schedule detailing the expected progress through time of the organization is put forth. (Gargola-Chicago) W69-01404

### ECONOMIC DERIVATION OF RESERVOIR OPERATING RULES,

Kentucky Univ, Lexington, Civil Eng Dept

L. Douglas James.

ASCE Proc, J of Hydraulics, Vol 94, No HY5, Pap 6111, pp 1217-1230, Sept 1968. 14 p, 4 fig, 7 tab, 10 ref

Descriptors: \*Flood control, Multiple-purpose reservoirs, Optimum development plans, \*Recreation, \*Reservoir operation, \*Water supply, Water aw, Water transfer, Simulation analysis

dentifiers: \*Economic simulation models, Rough River Reservoir.

Rules prescribing the amount of water which should be kept in a reservoir on a month by month basis throughout the year are needed to maximize been the conflicting storage requirements of flood control, recreation, and water supply in accordance with monthly demand patterns. Total potential benefits and economic loss functions for each of the three purposes were derived and used to derive a set of curves for determining optimum storage in Rough River Reservoir, Kentucky, for each month of the year. Practical and legal problems expected in implementing such rules are discussed. (Author) W69-01406

## OPTIMISATION IN THE USE OF THE MEANS

OF PRODUCTION AND TRANSMISSION, M. Adnet, P. Auges, and M. Dupoux. Int Conf Large High Tension Elec Syst, Paris, France, June 1968. Pap 32-15, 34 p, 8 fig, 2 ref, 4

Descriptors: \*Electric power production, Optimum use, Economics, Water utilization, \*Transmission (Electrical), Calculations, Models, Reservoir operation, \*Power system operations, Hydroelectric power, Thermal power, Foreign countries, Operations, Mathematical analysis, Irrigation, Water requirements.

Identifiers: France, Interconnected systems, Energy budget, Energy transfer.

Objectives and methods used by Electricite de France in operating its complex system of thermal and hydroelectric powerplants to assure uninter-rupted electrical energy to that country are described. Problems involved in obtaining maximum utilization of the equipment, overall powerplants, existing transmission network, and fuel reserves are considered. Managing hydraulic reservoirs for most effective use is discussed. Coordination of powerplants within the same valley must be considered for the best economic management of water supplies derived from drainage areas. Daily programs of starting and stopping generating units are important for economic system operation. The influence of system calculation must be considered for economic control of production and consumption. The essential task is to ensure the supply to consumers under correct conditions of frequency and voltage, while managing production of electric energy in the most economic manner. (USBR) W69-01422

## OPTIMUM PENSTOCK DIAMETER FOR HYDROELECTRIC POWERPLANTS AND PUMPING PLANTS,

California State Department of Water Resources,

Sacramento.

Ravinder K. Jain, and A. R. Griffith. Tech Memo No 34, Dept Water Resour, State Calif, June 1968. 25 p, 2 fig, 2 tab, 9 ref, append.

Descriptors: \*Penstocks, \*Hydroelectric power-plants, \*Pumping plants, Economics, \*Optimum design, Head losses, Cost comparisons, Steel plates, Computer programming, Mechanical engineering, Stress analysis, Friction, Excavation, Backfills, Protective coatings, Manning formula, Planning, Costs, Construction costs, Steel pipes.

Identifiers: Tehachapi Pump Plant (Calif), \*Computer programs, Annual costs, \*Computer-aided design, California, California State Water Proj.

An economical method is outlined for determining the optimum penstock diameter for hydroelectric powerplants and pumping plants, based on a minimum total annual cost. This total annual cost includes all costs of construction and the cost of power loss due to friction. All such factors are brought explicitly into the cost analysis utilizing a computer program. Laborious calculations are avoided and the relationships existing between the various cost aspects may be studied in greater detail because of the basic simplicity of this approach. Total computer cost is approximately \$1.50 for 2 sets of data. This method was developed while designing the Tehachapi Pumping Plant Discharge Lines. The computer input and output, example cases, and program listings are given. (USBR) W69-01431

### BULGARIA'S HYDRO-POWER POTENTIAL,

Liubomir S. Yordanov

Water Power, Vol 20, No 9, pp 368-375, Sept 1968. 8 p, 6 fig.

Descriptors: \*Hydroelectric powerplants, Rainfall, Runoff, Underground powerplants, \*River basin development, Pumped storage, Project planning, Snowmelt, Multiple purpose projects, Municipal water, Irrigation, Dams, Industrial water, Reser-

voirs, Pressure tunnels, Electric power, Geology, Foreign projects.

Identifiers: Bulgaria, \*Hydroelectric resources. Water use, Watershed management, Europe, \*River cascade systems.

Hydroelectric and pumped storage plants in service, under construction, or proposed in Bulgaria are described. Geomorphological, climatic, hydrological, soil, and biogeographical characteristics of the region are discussed. Data are given for each existing hydroelectric installation. River cascade systems under construction are described. In addition to the principal cascades, there are 58 reservoir sites with dams exceeding 15 m high, and 65 hydroelectric powerplants under construction. Potential developments planned for the next 10 to 12 yr are listed. Problems that must be considered in Bulgaria's hydroelectric power development include: insufficient rainfall; dry climate; and the inadequate system of natural river courses, rockfalls, vertical cliffs, and avalanches. Pumped storage is considered as a solution to these problems. One small experimental pumped storage plant exists, but others are under construction or planned. Bulgaria's power generating potential characterizes the general economic growth. Power output has increased from 45 kwh per capita in 1944 to 1400 kwh in 1966, and is expected to reach 2500 kwh in 1970 and 4500 kwh in 1975, the highest in the Balkans. (USBR) W69-01451

### SURVEY CONTROL FOR CONCRETE DAM CONSTRUCTION,

Bureau of Reclamation, Montrose, Colo.

Maynard J. Willis.

Proc Amer Soc Civ Eng, J Surv Mapp Div, Vol 94, No SU2, pp 169-188, Sept 1968. 20 p, 11 fig, 1 tab, 3 ref, append.

Descriptors: \*Surveying, Surveying instruments, Concrete dams, \*First order surveys, Construction, Second order surveys, Offsets, Bench marks, Monuments, Plane surveying, Theodolites, Triangulation nets, Arch dams

Identifiers: \*Surveys, \*Morrow Point Dam (Colo.), Construction control, Construction practices.

Precision survey controls for Morrow Point Dam, a double-curvature, concrete-arch structure, 465 ft high, were required through reconnaissance, site investigation, and preconstruction phases to satisfy specific needs of the designers, and to accommodate the rough terrain. Surveys for this type of project can be grouped into 2 convenient classifications; control and construction. Control surveys are directly related to geodetic principles. Construction surveys are used under localized application of plane surveying for structure layouts. Horizontal control surveys for Morrow Point Dam consisted of a triangulation grid based on the state coordinate system. Vertical control was elevation in feet above mean sea level, datum of 1929. After completing excavation for the access roads, a primary triangulation network was established with stations located adjacent to the powerplant open-cut area and the keyways for the dam. The method used in adjusting the triangulation scheme is presented. A series of bench marks was established from a line of first-order leveling by the U S Coast and Geodetic Survey, and extended the leveling to the vicinity of the primary features of the project. An electronic computer processed repetitious surveying calculations. (USBR)
W69-01457

### WATER IMPORT SYSTEMS FOR ARID LAND DEVELOPMENT.

Ralph M. Parsons Co., Los Angeles, Calif.

International Symposium About Increasing of Food Production in Arid Lands, Instituto Tecnologico de Estudios Superiores Monterrey, Monterrey, Nuevo Leon, Mexico, April 22-25, 1968. 16 p, 3 map, 2

### Field 06-WATER RESOURCES PLANNING

### Group 6B—Evaluation Process

Descriptors: \*Arid lands, \*Water resources development, \*Geographical regions, \*Climatology, Mexico, \*Reservoir storage, Water transfer, Economic feasibility, Rivers, Canals, Tunnels, Notes Water shortage, Hydroelectric power, Natural resources.

Identifiers: \*North America Water and Power Alliance, Canada, American Desert.

The North American Water and Power Alliance is thoroughly discussed in this article. The NAWAPA concept utilizes geographical and climatological features of the North American Continent to collect and store excess water of northwestern areas of the continent and distribute it to arid areas of Canada, the United States and northern Mexico. The concept envisions water deliveries from these surplus areas in times of drought into the American Desert about 9 years after initiation. The NAWAPA is economically feasible and financially within the existing money markets. (Blecker-Ariz) W69-01471

## ECONOMIC FACTORS IN THE IMPROVE-MENT OF ARID AND SEMI-ARID GRASS-LANDS.

Forest Service, Division of Range Management. For primary bibliographic entry see Field 03B. For abstract, see W69-01482

### 6C. Cost Allocation. Cost Sharing. Pricing/Repayment

SOCIALLY OPTIMUM PRICING POLICY FOR A PUBLIC WATER AGENCY,

Washington Univ., Seattle; California Univ.,

For primary bibliographic entry see Field 06A For abstract, see . W69-01215

### THE MARKET FOR WATER BASED OUT-DOOR RECREATION SERVICES IN NEW CAS-TLE COUNTY, DELAWARE,

Delaware Univ, Newark.

Univ Delaware Water Resources Center Contrib No 2, July 1966, 66 p, 5 fig, 18 tab, 55 ref, append. OWRR Project A-003-Del.

Descriptors: \*Marketing, \*Recreation, Recreational facilities, Water resources, Outdoors, Boats, Fish, Swimming, Public services, Statistics, Bibliographies, Delaware

Identifiers: New Castle County (Delaware), Water

Under a grant for the Water Resources Center of the University of Delaware acting under the Federal Government's Water Resources Research Act of 1965, an investigation of the allocation and development of the water related recreation market in New Castle County, Delaware, was un-dertaken. In the process of this research activity, the author found it helpful to develop a framework for the analysis, pulling together much of the literature in this field. What has emerged, we hope, is more than just a study of water resource development in one county but a framework to facilitate rational choice-making at the local governmental level everywhere. W69-01234

## WATER AND SEWER BOND SALES IN THE UNITED STATES, JANUARY - DECEMBER 1966.

Federal Water Pollution Control Administration, Washington, DC.

FWPCA Grant WP-00016, Fed Water Pollut Contr Admin, Div Pollut Surveillance, Jan-Dec 1966. 10 p, 14 tab.

Descriptors: \*Sewers, \*Construction costs, Costs, \*Financing, Interest rate, Interest, Investment.

This annual report of Water and Sewer Bond Sales in the United States contains data which are basic and necessary to the orderly and efficient management of water supply and pollution control programs. It reflects, in a measure, the extent of financing to fulfill these two important public services. The report also provides a ready source of economic reference for financial, investment and banking interests; for the building and contracting trades and professions; and for authorities responsi ble for providing public water supplies and sewerage systems. The publication series, over the years, is a good indicator of interest rate and construction cost trends in these two types of public utility. Data are presented in three categories according to the use of the proceeds from the sale: (1) Water, when the bonds have been sold to finance water facilities; (2) Sewer, to finance sewage facilities; and (3) Combination, to finance jointly water and sewage facilities where the portions attributable to each type are not designated. Data describing bonds sold to finance other types of construction in combination with water and/or sewage facilities construction are excluded. Data describing bonds sold to finance storm sewers are omitted, although these data are available. (Author) W69-01245

### IMPACT AND INCIDENCE OF TAXATION ON WATER UTILITIES IN RHODE ISLAND.

Rhode Island University, Kingston. Marvin Pitterman.

Univ Rhode Island Completion Rep A-005-RI, June 1966. 23 p, 8 tab, 15 ref. OWRR Project A-005-RI

Descriptors: Bibliographies, \*Public utilities, \*Taxes, Analytical techniques, \*Rhode Island, Analysis, Income, Investment, \*Water supply, Economic impact, Population, Community development. Economics. Identifiers: Economic evaluation.

This paper is a study of effect of taxation on water utilities in Rhode Island. It involves a detailed study of 6 private or quasi-municipal water utilities in Rhode Island with great disparity in size. The method of descriptive research was used to develop and solve problems by obtaining and interpreting necessary information and data. Facts used in this approach were obtained principally from Rhode Island Utilities Commission, annual reports of the 6 utilities, articles in daily newspapers, and interviews with local water authorities. Important conclusions reached were: (1) taxes do not detract from private or quasi-municipal water utilities development; (2) utility taxation does not lessen quality of service to the consuming public; (3) the private or quasi-minicipal water utility bears the impact of utility taxation; (4) the incidence of utility taxation is borne by the consuming public; (5) rate increases must be slightly higher due to utility taxation; (6) the Utility Commission protects the consumer from unwarranted rate increases and (7) the utility taxation does not prevent water utilities from servicing expanding areas. W69-01258

## VILLAGE OF ALBANY V GREATER LIVING-STON WATERWORKS CO )TRANSFER OF WATERWORKS FRANCHISE(.

193 So 2d 110-114 (Ct App La 1966).

Descriptors: \*Louisiana, \*Water works, Water rates, Utilities, Legal aspects, Judicial decisions, Local governments, Contracts. Identifiers: Franchises.

Village of Albany seeks to have franchise holder's transfer of waterworks franchise to water company declared invalid. The Louisiana Court of Appeals held that referendum approval of a franchise grant was not required where tax dollars were not being

used in the construction and operation of the franchise system. Even if approval of the mayor and aldermen were necessary before a franchise could be transferred by its holder to another, such approval had already been given in the present case by the grant of the franchise to the holder, 'his heirs, successors, or assigns.' Language of a statute that provided that a municipality 'may' authorize or assent to all transfers of franchises by the grantee and its successors, and assigns was permissive in nature. A municipal corporation may regulate rates on a system it owns or leases, but in nearly all other cases the Louisiana Public Service Commission regulates rates of privately owned utilities. (P. N. Smith-Fla) W69-01379

### STANDARDS, CHARGES, AND EQUITY,

Resources for the Future, Inc. For primary bibliographic entry see Field 05G. For abstract, see W69-01402

### 6D. Water Demand

## HACKENSACK WATER CO V BOROUGH OF UPPER SADDLE RIVER )ADMINISTRATIVE STANDARDS FOR WATER DIVERSION(.

88 N J Super 362, 212 A 2d 394-402 (1965).

Descriptors: \*New Jersey, Administrative agencies, \*Administrative decisions, \*Diversion, Diversion losses, Judicial decisions, Legislation, \*Water law, Water permits.

Identifiers: Minimum flow.

The case involved an appeal by a New Jersey borough and village from a determination of the Water Policy and Supply Council granting an application by Hackensack Water Company for approval of a diversion of water from the Saddle River by two wells. According to New Jersey law, in order to merit the Council's approval proposed plans for water diversion must: (1) be justified by public necessity; (2) provide for proper and safe construction of facilities; (3) provide for the prevention of contamination; (4) insure that any resulting reduction in the dryflow of a stream will not produce unsanitary conditions or otherwise injure public or private interests; and (5) be just and equitable to municipalities and their inhabitants with regard to present and future water needs. The court held that since the Council's decision did not so depart from the record evidence as to become arbitrary, capricious or unreasonable, it would not be set aside. The court noted that if conditions changed or if something was overlooked, the Council's decision was subject to review at any time in the public interest. Administrative law arguments were also discussed. (Patterson-Fla) W69-01394

### **ENVIRONMENTAL ANALYSIS AND REMOTE** SENSING.

Cold Regions Research and Engineering Laboratory, Hanover, N. H. J. N. Rinker, and R. E. Frost.

Seminar, Amer Inst Aeronaut Astronaut, Rocky Mt Sect, Colorado State Univ, Fort Collins, July 1968. 152 p, 34 fig, 2 tab, 388 ref, append.

Descriptors: \*Sensors, \*Aerial photography, \*Environment, Photography, Population, \*Population growth, Foods, Water supplies, Land utilization, Waste disposal, Water pollution, Agriculture, Bibliographies, Acoustics, Radar, Crops. Identifiers: \*Photointerpretation, \*Remote Sensors Images Agril recompagasage, Environe.

sensing, Images, Aerial reconnaissance, Environmental effects, Environmental engineering.

The need for environmental analysis is apparent when the world population explosion problem is considered. The environment that must satisfy the needs and desires of the expanding population is not inexhaustible; its components are so interrelated that a beneficial utilization of one can result in an unintended but detrimental influence on another. The increase in population may someday exceed our ability to house and feed people on a worldwide basis. Water demands rise with population increase and per capita requirements. The problems of waste disposal and pollution resulting from these increases are discussed. Remote sensing techniques could be a great aid to man as he studies his environment. Techniques and applications of photography, thermal sensing, radar, and acoustical sensors are discussed. An example demonstrates the amount and type of information that can be obtained from a detailed stereoscopic study of aerial photography. (USBR) W69-01467

### 6E. Water Law and Institutions

### WATER RESOURCES ADMINISTRATION IN DELAWARE.

Delaware University, Newark.

Roger Smith Hoeh.

Univ Del Water Resour Center Contrib No 1, Aug 1966. 175 p, 3 fig, 1 map, 122 ref. OWRR Project A-003-Del

Descriptors: \*Water resources, Water management, \*Water resources development, Water sources, Governments, Interstate compacts, Surface waters, Water conservation, Water pollution, Groundwater, \*Delaware, Legal aspects.
Identifiers: Delaware River Basin, \*Water

resources management.

The structure and functions of Delaware governmental agencies concerned with water resources are discussed. Future legal problems associated with water resources are apt to be concerned with the state's basic need: (1) to clearly define the scope of water rights; (2) to provide some mechanism for implementing and enforcing a water resources plan; and (3) to create a central advisory, information and policy coordinating center at the state level. Administratively, planning and development activities are conducted by separate agencies directly responsible to the Governor, while the other agencies are considered to be legally and formally autonomous. Delaware agency administrators depend to a considerable degree on informal agreements with their counterparts in other states. These agreements may attain a degree of permanence comparable to a formal, written agreement as the practice continues over an extended period. W69-01230

# PROBLEMS ARISING OUT OF MONTANA'S LAW OF WATER RIGHTS,

Albert W. Stone.

OWRR Project A-002-Mont, Mont Law Rev, Vol. 27, pp 1-18, 1965. 18 p.

Descriptors: \*Water law, \*Montana, \*Water rights, Legal aspects, \*Prior appropriation, Beneficial use, Adjudication procedure, Permits, Legislation, Administration, Water resources development.

Montana is limited in developing water resources by laws and administrative patterns which were by laws and administrative patterns which were formed before Montana became a state. It still recognizes 'use' rights--appropriations acquired without posting, filing, declaring or stating anything. This results in an indeterminate right, which must ultimately be established by future litigation, when the facts are most difficult to establish. In the meantime other developments are inhibited. The optional 'statutory method' of appropriation provides for local filing prior to commencement of works, and results in no record of the quantity of water actually appropriated upon completion, nor even whether any appropriation was completed. On adjudicated streams a court proceeding is required for appropriation. Although water rights may be transferred, the transferor can

transfer no better right than he had, and hence the transferee cannot use water in an amount or manner which is more burdensome. The transferee is limited to that which would have been the needs of his transferor. There is a need to turn to a completely administrative system for ascertaining existing rights, permitting future appropriations which are consistent with the public interest, and administering water distribution. (Author) W69-01233

#### ASPECTS OF THE SMALL WATERSHED PROGRAM IN IOWA,

Iowa University, Iowa City. For primary bibliographic entry see Field 04D. For abstract, see . W69-01255

### UNCERTAINTY IN WASHINGTON WATER RIGHTS.

Washington University, Scattle.

William Van Ness.

Water Resour Res Center, State Washington, Completion Rep, Feb 1967. 38 p, 4 append. OWRR Project A-002-Wash.

Descriptors: \*Public rights, Reparian rights, Water allocation (Policy), Water rights, Water law, Water permits, Decision making, \*Adjudication procedure, \*Judicial decisions, Prior appropria-\*Adjudication tion. Legislation.

The purpose of this paper is to objectively determine, insofar as presently available data allows, the present extent to which the central recording system for water rights and the procedures for making water rights a matter of record are sources of general uncertainty and title insecurity problems in the state of Washington. The primary analytical method chosen has been a detailed study of the decrees rendered in the fifty-eight statutory stream bed adjudications which have to date been conducted in this state. A secondary approach has involved a consideration of the Washington statutes and case law on water rights in an attempt to determine what role they play in eliminating or compounding title insecurity and problems of uncertainty now found in Washington water law. Because of the substantial similarity in the water law of the western states which follow the appropriation doctrine it is believed that the results of this study are indicative of problems-latent and apparent- in other states. (Author) W69-01261

## LEGAL ASPECTS OF WEATHER MODIFICA-TION--SNOW PACK AUGMENTATION IN WYOMING.

Wyoming University, Laramie. For primary bibliographic entry see Field 03B. For abstract, see . W69-01263

## HANDBOOK OF BASIC WATER LAW,

Louisiana State Univ., Baton Rouge. George W. Hardy, III.

La Water Resour Res Inst, Bull 1, June 1966. 77 p. OWRR Project A-001-La.

Descriptors: \*Civil law, \*Water rights, Legislation, \*Water law, State jurisdiction, Administrative agencies, Appropriation, Eminent domain, Withdrawal, Water conservation, Water pollution, Irrigation, Louisiana, \*Water districts. Identifiers: Baton Rouge Area (La).

The materials compiled in this bulletin are intended to form a basic handbook for the further study of possible solutions to the legal problems encountered in the study of salt water intrusion into aquifers utilized as a source of fresh water in East Baton Rouge Parish and the surrounding area. The bulletin consists of 3 parts: (1) a memorandum by Dean Frank Trelease of the University of Wyoming College of Law exploring problems of water conservation on a broad scale; (2) collected memoranda summarizing the law of several states other than Louisiana which have faced problems of water use and conservation; and (3) a compilation of relevant statutes and court decisions regarding water law, water use and control, and water conservation in Louisiana. This material will furnish a basis for more specific study and planning when sufficient geological, economic, and engineering data have been procured to permit the conception and presentation of plans for legal action to assure a steady supply of fresh water for industrial and W69-01267

## DUVAL V THOMAS )RIGHT TO USE OF EN-TIRE NONNAVIGABLE LAKE BY OWNER OF A PORTION OF THE LAKE(.

State of Florida, Tallahassee.

114 So 2d 791-795 (Fla 1959).

Descriptors: \*Florida, Judicial decisions, Lakes, \*Reasonable use, Barriers, Limiting factors, Access routes, Nonnavigable waters, \*Boundaries (Property), Legal aspects, \*Tourism.

Petitioners owned land on either side of respondant. Each constructed a barrier extending into a landlocked, nonnavigable lake to a corner common to all the parties, the result being to block respondant's access to the rest of the lake. Respondant brought an action to have the barriers removed, which was granted. The Supreme Court granted certiorari based on a possible conflict between common law and civil law rules. Petitioners urged the common law rule that the owner could use only that water overlying his fee. The court rejected this contention, stating that they were bound to the common law only when it was clear and directly applicable. An owner of a portion of a lake was entitled to reasonable use of the entire lake as long as he does not interfere with the rights of others. The court cited tourism as an important consideration in this ruling. (Sisserson-Fla) W69-01278

#### ANDERSON V COL SOVEREIGNTY LANDS(. COLLINS SALE OF State of Florida, Tallahassee.

111 So 2d 44-50 (2d D C A Fla 1959).

Descriptors: \*Florida, Judicial decisions, \*Administrative agencies, Beds, Islands, \*Riparian rights, Remedies, Legal aspects, Administration. Identifiers: \*Sovereignty lands, Sale of land.

Appellants brought an action to void the sale of sovereignty lands, islands and submerged lands to private parties. Appellants alleged gross abuse of discretion by the Tenatees of the Internal Improvement Fund, the agency which controls title to the tidal lands of Florida. Appellants, citizens of St. Petersburg, joined the city of St. Petersburg as defendants since, as owners of the upland adjacent to the land in question, they did not raise objections to the sale. Appellants contended that the private parties fraudulently represented that they were the owners of the uplands adjacent to the sovereignty lands to be sold, and that the Trustees failed to investigate that claim. The trial court found that the Trustees carefully and correctly followed the statutory procedure for the sale of sovereignty lands. They satisfied the only objection that was raised. The judgment was affirmed. (Sisserson-Fla) W69-01280

### UNITED STATES V 2979.72 ACRES OF LAND CONDEMNATION PROCEEDING(.

270 F 2d 707-714 (4th Cir 1959).

Descriptors: \*Judicial decisions, \*United States, Water law, Legal aspects, \*Condemnation, \*Eminent domain, Navigable waters, Riparian rights, Market value, Severance, Flow.

## Field 06-WATER RESOURCES PLANNING

## Group 6E-Water Law and Institutions

Identifiers: Flowage easements.

An electric power company purchased a flowage easement from a riparian owner. Then, the fee owner conveyed the fee to the United States for 1 dollar. The United States after condemning the flowage rights contends that the power company should have no compensation because the right has no value since the power company has no right to use the waters of the navigable stream. The court held that although the power company could not use the stream for power purposes without the United States' approval, the United States could not use the land either as long as the power com-pany possessed the easement. Compensation was thus due for losing the right to flow. The measure of the damage is the difference between the fair market value of the land before and after the taking of the easement. Included in these damages was compensation for severance because the power company in purchasing the easement had also purchased the executory right to sever lands not actually covered by the easement rights. (Childs-Fla) W69-01283

DIVISION OF WATER RIGHTS AND OTHER INCORPOREAL HEREDITAMENTS; PARTI-TION OF WATER IN A NATURAL STREAM, ETC.

State of Massachusetts, Boston.

Mass Ann Laws Ch 241, Secs 36-37 (1967).

Descriptors: \*Massachusetts, Legislation, \*Water rights, \*Equitable apportionment, Administration, \*Non-navigable waters, Riparian rights. Identifiers: Division of rights.

Sec 36 provides that joint tenants or tenants in common of an incorporeal hereditament such as a mill privilege or water right may be compelled to divide such right in the same manner as provided in this chapter (relating to partition of land) for divi-sion of real property. The commissioners appointed to make the partition shall recommend the best method of setting off the respective shares, and the court may make equity-type decrees and orders pursuant thereto. A sale is authorized, where one of the joint owners so requests. Sec 37 provides that partition may be made of a non-navigable natural stream, where the banks are owned by different riparian proprietors. (Williams-Fla) W69-01291

## GOVERNOR AND COUNCIL TO REPRESENT COMMONWEALTH IN U S GOVERNMENT SURVEYS.

State of Massachusetts, Boston. For primary bibliographic entry see Field 07A. For abstract, see W69-01294

DIVISION OF WATER POLLUTION CONTROL. State of Massachusetts, Boston,

Mass Ann Laws, Ch 21, Secs 26-50 (1967).

Descriptors: \*Massachusetts, \*Legislation, \*Administrative agencies, Water pollution, Water ministrative agencies, Water pollution, Water quality, Water conservation, Water districts, quality, Water conservation, Water districts, Sewage, Industrial wastes, Federal government, Standards, Reservoirs, Pollution abatement, \*Water management, Financing.

The Mass Clean Waters Act created the Division of Water Pollution Control to supervise the prevention, control, and abatement of water pollution. These statutes designate the structure and purposes of the division, which include: (1) Encouragement of cities to adopt water pollution plans; (2) Cooperation with federal and state agencies; (3) Research; (4) Adoption of water quality standards; (5) Periodic examinations of water quality; and (6) Preparation of a state water pollution plan. The division is authorized to establish, consolidate, or dissolve water pollution abatement districts. The water resources commission may construct reser-

voirs to regulate the water flow. The Director of the Division of Water Pollution Control or his representative is authorized to enter any land at reasonable times to inspect or test for water pollution. A \$100 per day penalty is provided for persons guilty of causing water pollution. All new outlets for discharge of sewage or industrial wastes require a permit from the division. The director may issue the permit under whatever conditions necessary to protect the water quality. If the conditions are not met the violator may be enjoined by the Supreme Court. (Watson-Fla)

SECS 143-354 ORDINARY POWERS AND DU-TIES OF THE BOARD OF WATER RESOURCES--SECS 143-355 TRANSFER OF WATER CERTAIN POWERS, DUTIES, FUNCTIONS AND RESPONSIBILITIES OF THE DEPART-MENT OF CONSERVATION AND DEVELOP-MENT AND OF THE DIRECTOR OF SAID DE-PARTMENT.

State of North Carolina, Raleigh.

North Carolina Laws Ch 1071, 1117 (1967).

Descriptors: \*North Carolina, Legislation, \*Administrative agencies, Administration, Long-term planning, Federal government, Project planning, \*Water storage, Local government, Political aspects, Wells, \*Well regulations, Water use.

Sec 143-354 provides that the Board of Water and Air Resources is to carry out a program of planning and education with reference to conservation and beneficial use of water resources. It is to: (1) investigate local governments' needs for federal water supply storage projects; (2) warn them of impending water shortages; (3) suggest legislation; (4) hold public hearings; (5) adopt rules and regulations; (6) provide federal agencies with assurances of nonfederal cooperation in federal projects; and (7) to assign or reassign to local governments any interests of the state in federal water storage projects. Sec 143-355 sets out the duties of the Department of Water Resources. The Department is to act as an intermediary with the federal government, engage in studies and long-range planning, administer water related programs, and carry on various other activities. Well drillers are required to register with the Department, supply it with samples of cuttings, and furnish certain information upon completion of the well. Upon request, water users may be required to provide water use information to the Department. (Williams-Fla)

GEORGIA WATER QUALITY CONTROL ACT. State of Georgia, Atlanta.

Ga Code Ann, Secs 17-501--17-530 (1967).

Descriptors: \*Georgia, Legislation, \*Administrative agencies, Regulations, \*Water resources, \*Water quality control, Water pollution, Sewage, Industrial wastes, Project planning, Permits, Standards, Surveys, Water purification.
Identifiers: Federal Water Pollution Control Act,

\*Div for Ga Water Quality Control.

The policy of the Act is to utilize the water resources of Georgia to the maximum benefit of the people. To achieve this result, a water quality control program is established. The composition and organization of the Water Quality Control Board, which administers this program, are described. Among the powers and duties of the Board are: (1) engaging in research related to pollution; (2) determining the existing pollution conditions; (3) preparing a plan for pollution prevention; and (4) establishing standards of water purity. The Act sets forth the powers and duties of the executive secretary for the Division for Georgia Water Quality Control. All employees of the Division are controlled by the state merit system. All facilities, personnel, funds and functions utilized for water quality control by any state agency are transferred to the Division for Georgia Water Quality Control. The Act makes the disposal of sewage, industrial wastes, or other wastes into waters of the state unlawful except when in compliance with the specified regulations. The methods for enforcing and appealing regulations are described. The Water Quality Control Board is the state agency for all purposes of the Federal Water Pollution Control Act. (Childs-Fla) W69-01300

WATER RESOURCES CENTER )GA. INST. OF TECHNOLOGY(.
State of Georgia, Atlanta.
For primary bibliographic entry see Field 09A.

For abstract, see . W69-01301

CANAL COMPANIES. State of Georgia, Atlanta.

Ga Code Ann Secs 17-101--17-114 (1967).

Descriptors: \*Georgia, Legislation, State jurisdiction, \*Canals, \*Canal construction, \*Navigation, State governments.

A petition to the Secretary of State is required of any group of persons desiring to incorporate a company for the purpose of constructing, operating and maintaining a canal. The Secretary of State shall issue a 30 year certificate, to be kept on file. Procedures for organization are set out. The powers of the corporation, such as to make contracts, acquire property and construct canals, are delineated. The corporation may not obstruct navigation, and several other duties and limitations are imposed. The corporation is authorized to enlarge canals, allow others to withdraw waters from their canals, and permit goods to be transported through them. Whenever a canal or its backwaters encroach upon a public road, the corporation must restore the road to its original condition, by the use of bridges, etc., at its own expense. The corporation is authorized to sell, lease or mortgage its property in order to obtain money to maintain its works. The corporations created hereunder shall be subject to taxation. (Williams-Fla) W69-01302

AN ACT TO AMEND...AN ACT CONCERNING THE ESTABLISHMENT, DEVELOPMENT AND OPERATION OF PUBLIC PORTS, CREATING THE INDIANA PORT COMMISSION AND DEFINING ITS POWERS AND DUTIES.

State of Indiana, Indianapolis. For primary bibliographic entry see Field 04A. For abstract, see W69-01303

AN ACT CREATING A POLLUTION CONTROL AGENCY AND CREATING AN OFFICE OF DIRECTOR THEREOF: PROSCRIBING THEIR POWERS AND DUTIES: EMPOWERING THE GOVERNOR TO ACT IN AN EMERGENCY. State of Minnesota, St. Paul.

Minnesota Laws Ch 882 (1967).

Descriptors: \*Minnesota, Legislation, \*Administrative agencies, Water quality, \*Water pollution control, Administration, \*Air pollution, Land use,

The seven-member Minnesota pollution control agency is created. It is to be broadly representative of skills and experience necessary to carry out the purpose of this act. This agency takes the place of the water pollution control commission, and inherits its powers and responsibilities. The office of director is established, and he shall be appointed by the governor. The director is to organize the commission, is authorized to enter contracts, and is designated the state's agent in applying for, receiving and disbursing federal funds. Assistance from

### Water Law and Institutions—Group 6E

other state agencies may be required, upon request to the governor. The provisions relating to water pollution are contained in Chapter 115 of the Minnesota Statutes. The powers provided in this act relate to air pollution. A study of solid waste control and land uses in areas affected by air and water pol-lution is directed. (Williams-Fla)

## AN ACT TO PROTECT THE PUBLIC HEALTH AND TO CONSERVE AND PROTECT THE WATER RESOURCES OF THE STATE.

State of Indiana, Indianapolis. For primary bibliographic entry see Field 05D. For abstract, see . W69-01305

## AN ACT AMENDING THE ACT OF MAY 15, 1945 )PL 547(, ENTITLED, AS AMENDED, 'AN ACT RELATING TO SOIL CONSERVATION AND SOIL EROSION...'.

State of Pennsylvania, Harrisburg. For primary bibliographic entry see Field 03F. For abstract, see . W69-01308

### AMENDMENT TO THE SANITARY WATER **BOARD ACT OF 1951.**

State of Illinois, Springfield. For primary bibliographic entry see Field 05A. For abstract, see W69-01309

### RATIFICATION OF THE UPPER MISSISSIPPI RIVERWAY COMPACT BY THE STATE OF IL-LINOIS

State of Illinois, Springfield.

Illinois Laws 1967, Ch H 756.

Descriptors: \*Illinois, \*Interstate compacts, Regional development, Administrative agencies, Legal aspects, Administration, Financing, Taxes, \*River basin development, Interstate commissions, \*Mississippi River Basin, Legislation, State governments, Federal government, Water law, Water law, Water districts, Water resources development, Planning, Water policy, Standards.

The upper Mississippi Riverway Compact between the states of Iowa, Minnesota, Wisconsin and Il-linois is herein set out and ratified by the State of Illinois. The Upper Mississippi Riverway Commission is established. The Commission is specifically empowered to establish and maintain recreational facilities and programs; to promulgate plans for pollution abatement, control of erosion, and diversions of waters; to hold public hearings; and to make contracts. Generally, the Commission's powers are expressed in broad terms with emphasis upon co-ordination of all state and federal programs within the region. Representation on the Commission is required to be equal among member states, and taxes imposed by the Commission and approved by the states' legislatures are to be apportioned equally. Ratification by three states is required to effectuate the compact. A party state may withdraw by enacting a repealing statute. The Director of Conservation in Illinois is appointed as one of the state's commissioners, and fiftythousand dollars is appropriated to the Commission. (Pfeiffer-Fla) W69-01310

### PURE WATERS DEVELOPMENT ACT. State of Illinois, Springfield.

Illinois Laws ch H 1245 (1967).

Descriptors: Legal aspects, Legislation, Local governments, State governments, Water law, \*Water resources development, Water pollution control, Water policy, \*Illinois, \*Multiple-purpose projects, Project planning, Administrative agen-

cies, \*Recreation, Water supply, Water management (Applied), Flood control, Expenditures, Government finance, Government Resource development.

The purpose of the Illinois 'Pure Waters Development Act' is to provide programs for the conservation, development, use and management of the state's water resources. The Pure Waters Board is empowered to finance programs with funds derived from the sale of bonds pursuant to the 'Pure Waters Development Bond Act.' In Article 2 of the Act, the Pure Waters Board is empowered to match local appropriations in order to complete projects conforming to the comprehensive statewide outdoor recreation plan. It is provided that project priorities be based on the multiple use concept of providing water management along with recreation utilization. Article 3 of the Act empowers the Board to assist in financing local pollution control projects, including sewage treatment facilities. Articles 4 and 5 allow the Board to assist in financing local water supply facilities and state wide flood control projects. In Article 6 the Board is empowered to finance land acquisition for existing state agencies and the construction and development of state water resources projects by existing state agencies. (Pfeiffer-Fla)

## AN ACT TO AMEND SECS 6111.01, 6111.03, AND 6111.31 OF THE REVISED CODE TO EXTEND TAX EXEMPTIONS FOR INDUSTRIAL WATER POLLUTION CONTROL FACILITIES.

State of Ohio, Columbus. For primary bibliographic entry see Field 05D. For abstract, see . W69-01312

#### CAUSEY V GRAY )BOUNDARY DISPUTE BETWEEN RIPARIAN OWNERS(.

243 A 2d 575-585 (Md 1968).

Descriptors: Riparian rights, \*Boundaries (Property), \*Riparian owners, Maryland, Judicial decisions, \*Landfills, Accretion, \*Equitable apportionment, Jurisdiction, Water law, Boundary disputes, Legislation, Relative rights, Remedies, Rivers

This action involved a boundary dispute between riparian owners. The parties were adjoining owners of riparian land on the Rhode River. The area in front of both parties' riparian land had been filled in. Plaintiff placed a retaining wall and pier along the water's edge. The boundary in dispute was the line from the water's edge to the end of the boundary between plaintiff's and defendant's fast land. Plaintiff sought a declaratory judgement that he was owner of certain land along the boundary. De-fendant demurred to plaintiff's complaint on the grounds that plaintiff had an adequate remedy at law in trespass. The court overruled the demurrer, saying that equitable apportionment of riparian rights could not be obtained in a court of law. The court reviewed statutory changes in the common law of riparian rights in Maryland. (Kirkconnell-W69-01344

# LANE V MCEACHERN )TITLE TO LAND BETWEEN HIGH AND LOW WATER MARK(. 162 S E 2d 174-176 (S C 1968).

Descriptors: \*South Carolina, High water mark, Low water mark, Rice, Judicial decisions, Navigable waters, \*Ownership of beds, Swamps, Marshes, Boundaries (Property), Water law, Banks, Navigable rivers, Fresh Water marshes. Identifiers: \*Patents (Land), \*Grants (Land).

This was an action for a declaratory judgment as to ownership of land claimed by plaintiff and the State of South Carolina. The land in question is situated on the east side of the Edisto River, a fresh-water navigable river affected by the tide. The land in its natural state was fresh-water river swamp adjacent to the river lying between the mean high and low water marks. The land has been enclosed by banks and used as a rice field since 1794. Plaintiff traces his title to a grant from King George II in 1734. This grant described the land, but made no mention of the low water mark. The State now asserts title to the land below the mean highwater mark. The court held that no justicable issue existed. The state admitted that the described land was in fact granted to plaintiff's predecessor by King George II, and hence the rule of construction that such grants extend only to the highwater mark did not apply. The court further held that since plaintiff had good title to the land, he had a right to maintain the banks around the land. (Kirkconnell-Fla) W69-01347

#### SEACOAST WATER COMM'N V CITY OF PORTSMOUTH )RIGHT OF MUNICIPALITY TO WATER SUPPLY(.

203 A 2d 649-656 (N H 1964).

Descriptors: \*Eminent domain, Federal Government, Cities, Municipal water, \*Water contracts, \*Water rights, Prior appropriation, Condemnation, Utilities, Dams, Reservoirs, New Hampshire, Judicial decisions.

The Federal Government attained through power of eminent domain land located in the city of Portsmouth. The water rights of the city were located within this area. In consideration for the city giving up its chief source of water supply, the Government promised to furnish a replacement supply of like quantity and quality. To fulfill the promise the Government deeded to Portsmouth its rights, title, and interest in Bellamy Dam and Reservoir. The plaintiffs in this action alleged that the city of Portsmouth had no appropriative, statutory, or preemptive rights to the water in the Bellamy River project. They further alleged that the city of Portsmouth, and the USA, as its agent, were depriving plaintiffs of rights and interests in the water. The Supreme Court of New Hampshire tended that the city had the right and power to acquire the water rights in dispute. The rights were received as consideration for giving up their former supply. Also, it is lawful for a municipality to own land in another community for the purpose of a water supply. (Harriett-Fla) W69-01348

#### UNITED STATES V 50 FOOT RIGHT OF WAY COMPENSATION FOR RIGHT OF WAY OVER SUBMERGED LAND(. 337 F 2d 956 (3 CCA 1964).

Descriptors: \*Judicial decisions, United States, \*Eminent domain, Condemnation, Right-of-way, Legal aspects, Riparian rights, \*Beds, Ownership of beds, Federal government, Condemnation value, \*Compensation

The United States brought a proceeding to condemn a fifty-foot right-of-way across a riparian owner's (Bergen Point Iron Works) land above the highwater mark and across such owner's submerged land under Newark Bay. The U S District Court allowed compensation only for the right-ofway across the upland and denied any compensation for use of the submerged land or interference with Bergen Point's access thereto. On appeal, the Third Circuit Court of Appeals held that where a private owner holds title to submerged lands, the United States could condemn a portion thereof without paying compensation only where it was an aid to navigation or necessary to its control. In this case, the mere running of a pipeline over submerged land could not be considered an aid to navigation, and the United States was required to pay just compensation for the use of Bergen Point's submerged land and the interference with its access thereto. (R. F. Williams-Fla) W69-01351

## Field 06-WATER RESOURCES PLANNING

### Group 6E—Water Law and Institutions

BURKHART V CITY OF FT LAUDERDALE )RIPARIAN RIGHTS -- INGRESS AND EGRESS(.

168 So 2d 65-70 (Fla 1964).

Descriptors: \*Public rights, Judicial decisions, \*Florida, Accretions (Legal aspects), \*Riparian rights, Easements, Boundaries (Property), Local government, Navigable waters, Riparian land, Relative rights.

Identifiers: \*Street easements, Plats.

This was an action by landowners to have themselves declared owners of certain accretions in New River Sound, a navigable body of water in Broward County, Florida. On the original subdivision plat a street easement ran along the water's edge, but the plat specifically reserved to owners of lots along the street riparian rights in the waters of New River Sound. The court determined that at the time of the plat, no land existed between the street easement and the water's edge. The question was whether the accretions in front of petitioners' lots belonged to petitioners, or were a part of the street easement. This court held that due to the specific reservation of riparian rights to lot owners in the plat, title in fee to the accretions was in petitioners', subject to the public right of ingress and egress to the water from the street. The court said the intent of the dedicator controls. (Kirkconnell-Fla) W69-01353

### TAPOCO, INC V PETERSON )PUBLIC RIGHT TO NAVIGABLE ARTIFICIAL LAKES(.

373 S W 2d 605-609 (Tenn 1963).

Descriptors: Tennessee, \*Hydroelectric project licensing, Navigable waters, Riparian land, Artificial watercourses, Lakes, Riparian rand, Artificial watercourses, Lakes, Riparian rights, \*Ownership of beds, \*Recreation, \*Boats, Remedies. Identifiers: \*Houseboats.

Plaintiff public service corporation brought suits against defendant owners of houseboats to require the removal of said houseboats from a lake. The lake was the artificial result of plaintiff's construction of a dam across a navigable stream. The lake covered riparian land held in fee by plaintiff. The court held that land, which in its natural state was not covered by any navigable body of water when granted, retains its character of private property when by force thereafter extended artificially, it becomes submerged by a navigable body of water. Therefore, defendants had no right to moor their houseboats. Dicta indicates that while the artificial lake was available for public recreation under the license granted plaintiff by the Federal Power Commission, defendants' houseboats interfered with fishing, boating, and skiing, and should be banned (Crabtree-Fla)
W69-01354

# MOUNTAIN SPRINGS ASS'N V WILSON )EASEMENT OF USE AND ENJOYMENT OF

81 N J Super 564 196 A 2d 270-278 (1963).

Descriptors: \*Easements, Right-of-way, Lakes, Streams, Ownership of beds, Riparian land, \*Community development, \*Public rights, \*Recreation, Relative rights, Zoning, New Jersey. Identifiers: \*Covenants.

An association of property owners brought action against grantees of a member of the association for construction and determination of rights and liabilities under certain covenants and restrictions contained in the deeds. The relevant portion of the deeds granted an easement for use and enjoyment of a lake and stream owned by the association. The court held, that since the easement was in common with other property owners, the association could not require grantees to contribute to the association for maintenance of the lake and stream nor could the association impose rules and regulations on the grantees in their use of facilities granted under the easement. (Crabtree-Fla) W69-01356

### TOWN OF MOULTONBORO V BISSONNETTE )BOATHOUSE ON PUBLIC RIPARIAN LAND(.

196 A 2d 703-706 (N H 1963).

Descriptors: New Hampshire, \*Boat-launching ramps, Ownership of beds, \*Prescriptive rights, Riparian land, Riparian waters, Easements, Leases, \*Public lands, Navigable waters, Judicial decisions. Identifiers: \*Boathouses, Public Trust Doctrine

This was an action by a town to restrain defendant from maintaining a boathouse in waters of a lake directly in front of plaintiff's property on the shore of the lake. Held, inter alia, that where the town claimed title to the landing place by virtue of its charter of 1763, and a vote of town meeting in 1818 appointed a committee to look after the landing place, and since the town had exercised dominion over the landing place by various leases executed in 1929 and had attempted to prevent defendant from rebuilding his boathouse, that the town had standing to sue, and had a valid title in fee. Inasmuch as the town's right to access to and from the landing place would be adversely affected by defendant's boathouse, and injunction against defendant was proper. (Crabtree-Fla) W69-01357

### COUNTY OF SARASOTA V NEVILLE )FILL IN NAVIGABLE FLORIDA WATERS(.

158 So 2d 533-534 (Fla DCA 1963)

Descriptors: \*Judicial decisions, \*Florida, Statutes, Riparian land, Permits, Remedies, \*Bulkhead lines, Dredging, \*Local governments. Identifiers: Injunction, Fill permits.

In a per curiam decision the District Court of Appeals on interlocutory appeal held that the Sarasota County Water and Navigation Control Act (Ch. 57-1853, Special Acts 1957, Laws of Florida) made the Sarasota County Water and Navigation Control Authority, as opposed to Sarasota County, the only permitted party plaintiff in a suit to enjoin littoral owners from further adding to their lands or constructing any islands in the bay without obtaining a permit. Chapter 253, Fla. Stat. clearly reflects this legislative intent. Although the Authority is composed of the County Commissioners, the board members as County Commissioners have no rights as plaintiff in the case, and the trial court's order dropping the County as party plaintiff should be affirmed. (MacMillan-Fla) W69-01358

# MILLER V COPPAGE )DROWNING IN DREDGED HOLE IN NAVIGABLE WATER(.

261 N C 430; 135 S E 2d 1-6 (1964).

Descriptors: North Carolina, Judicial decisions. \*Drowning, Swimming, \*Hazards, Recreation, \*Dredging, Excavation, Safety, Navigable waters, Ownership of beds, Riparian rights.

This was a wrongful death action to recover damages for the drowning death of plaintiff's seven year old son in the Neuse River. Defendant's were sued because plaintiff alleged that their dredging operations created a hazard which proximately caused the boy's death. The public used Neuse River for recreation for many years. At the point of the drowning, the river was shallow and safe for non-swimming children. Defendants, who were not riparian owners, excavated a large hole not far from shore and did not post it. It was held that defendant's had no right to dredge in the navigable river, but that there was no evidence of proximate cause, and a non-suit was proper. Plaintiff did not establish that the boy was a non-swimmer or where the body was found. (Crabtree-Fla) W69-01360

VOLPE V MARINA PARKS, INC )RIPARIAN RIGHTS(. 220 A 2d 525-531 (R I 1966).

Descriptors: \*Rhode Island, \*Riparian rights, \*Boundaries (Property), Boundary disputes, Riparian land, Judicial decisions, Shores, Water law, Relative rights.

This action involves a dispute between two landowners as to riparian rights. Both claim title through a common grantor. A platted street ran along the bay between Long Point and Shell Point. The original plat showed no land between this street and the water. Complaintant claims a right to wharf into the bay in front of his property, which is shown on the plat as bordering on the street. Respondent claims all riparian rights along the bay between Shell Point and Long Point. Respondent's title is derived from a conveyance of 'lots A and B. . . together with all riparian, water, shore, and fishing rights appurtenant thereto . . . 'located between Shell Point and Long Point. The court held that the grantor intended to convey all riparian rights between Shell and Long Points to respondent's predecessor. Upon abandonment of the platted street, complaintant took only to the center of the street, not to the water's edge; hence complaintant had no riparian rights. Title to the property between the street and the water's edge, and the riparian rights thereto, were in the respondent. (Kirkconnell-Fla) W69-01361

## TREUTING V BRIDGE AND PARK COMM'N )VALIDITY OF SALE OF SUBMERGED LANDS(.

199 So 2d 627-634 (Miss 1967).

Descriptors: \*Mississippi, Ownership of beds, Navigation, Legal aspects, Judicial decisions, Navigable waters, Landfills, Land forming, Land reclamation.

Identifiers: Obstructions to navigation.

This involved a sale of an island and submerged lands to the Biloxi Bridge and Park Commission by the State of Mississippi for the construction of a development project. This was held to be a valid exercise by the state as trustee of submerged land, since it would not interfere with navigation, would in fact improve navigation, and would have many other beneficial effects. The state's ownership of submerged lands as trustee for the people of the state is not a constitutional doctrine, but rather a common-law doctrine. A state constitutional provision prohibiting the legislature from authorizing permanent obstructions to navigable waters does not prohibit the sale of submerged lands and sub-sequent filling of these lands because it is directed toward free navigation and has nothing to do with waters not suitable for navigation or the sale of sub-merged lands. (P. N. Smith-Fla) W69-01362

### U S V 738.75 ACRES )TITLE TO ACCRETED LAND(.

263 F Supp 608-612 (E D Ark 1967).

Descriptors: \*Condemnation, Riparian rights, Riparian land, Water law, Legal aspects, Navigable water, \*Accretion (Legal aspects). Identifiers: Adverse possession.

The question in the condemnation action involved the title to riparian land. The land was formed by accretion on the bank of the Arkansas River. The first party claims the land as being an accretion to his property. The second party claims the land by adverse possession. The court held that under Arkansas law, the title to lands formed by accretion vests in the riparian owner. However, the court found that the second party was in actual adverse possession of the property and thereby gained title to it. (Horner-Fla) W69-01365

## Water Law and Institutions-Group 6E

## ROSE V STATE )DAMAGES FOR DESTRUCTION OF WATER SUPPLY(.

289 N Y S 2d 553 (App Div 1968).

Descriptors: \*Judicial decisions, \*New York, Salvage value, Market value, Evaluation, Compensation, Appropriation, \*Riparian rights, State governments, \*Condemnation value, Condemnation, Landfills, Relocation, Water supply, Road construction, Highways, Project feasibility, Interest rate, Legislation.

Claimant owned land with river frontage upon which he operated a crushed stone and ready-mix concrete business. For highway purposes the State of New York permanently appropriated a portion of the river bed, and in so doing destroyed claimants' existing source of water as well as access to the river, and simultaneously placed fill along this portion of the property thus completely separating claimants' property from the river at this point and destroying the riparian previously enjoyed. The trial court awarded claimants \$208,615 for permanent appropriation of riparian rights and destruction of the water system, plus \$45,000 for temporary interference with and taking of the water supply. When claimant learned that his existing water source was to be destroyed, engineering tests were conducted to determine whether a suffi cient water supply could be found elsewhere on or near the property. The court held that no such plan was feasible and that neither reasonable efforts nor expenditures would have prevented or mitigated the destruction of claimants' water supply. court affirmed the assessment of damages to improvements by market value of each fixtures less its salvage value. One judge dissented. (Smodish-Fla)

# THOMPSON V JOINT DRAINAGE DIST NO. 3-11 )FINANCING DRAINAGE DISTRICT IMPROVEMENTS(.

143 N W 2d 326-331 (Iowa 1966).

Descriptors: \*Assessments, \*Drainage districts, Statutes, Laterals, \*Iowa, Judicial decisions, Taxes.

This opinion involves an action to cancel levy of assessments for work done on a portion of a drainage district. The Winnelago-Kossuth Joint Drainage District included eleven laterals and several numbered drainage districts. The work in issue was done on lateral eight and Drainage District No. 22 The cost of the work amounted to about 86% of the original cost plus improvements to the area to be assessed. A statute required notice and a hearing to property owner, affected by an assessment if the estimate and cost of repair exceeds fifty percent of the original total cost of the district plus subsequent improvements. The question for resolution on appeal was whether the percentage limitations were to be applied to the entire joint district or only to the lateral and drainage district affected. The Supreme Court of Iowa held that the percentage must apply to the lateral and drainage district afsince these property owners would pay the whole bill through assessments. Since notice and a hearing were not provided as directed by the statute, the entire assessment was declared void. (Harriett-Fla) W69-01369

# WINIECKE V SCHEURER )RIPARIAN RIGHTS ON ARTIFICIAL CHANNELS(. 3 Mich App 178, 141 N W 2d 717-719 (1966).

3 Mich App 1/8, 141 N W 2d /1/-/19 (1966).

Descriptors: \*Channels, \*Spoil banks, Riparian land, \*Riparian rights, \*Littoral proprietorship, Contracts (Legal aspects), Judicial decisions, Michigan, Land use.

The two defendants along with three others were co-owners of a tract of land fronting on a channel they had built. The defendants purported to sell by a land sales contract some lots to the plaintiffs. The agreement restricted the vendors from crecting any structure on the land between the lots and the

channel. When later the vendors increased the size of the spoil bank while working on the channel, plaintiffs sought injunctive relief to get the spoil bank removed. The trial court decision to deny injunctive relief was affirmed in this opinion. The bases for denial was: (1) that no riparian or littoral rights were involved since plaintiffs knowingly purchased channel lots; (2) the written agreement was not binding since the two defendants did not have authority to sign for the others. (Harriett-Fla) W69-01370

# BOARD OF EDUCATION OF UNION FREE SCHOOL DIST NO 11 V NYQUIST )DETERMINATION OF HIGH WATER MARK(.

274 N Y S 2d 229-235 (Sup Ct Albany County, N Y 1966). 51 Misc 2d 902.

Descriptors: Water law, Legal aspects, Judicial decisions, Boundaries (Property), \*High water mark, Tidal waters, \*New York.

This case dealt with the determination of the boundary of a school district which was described as being the high water mark on a certain island in the Atlantic Ocean. The court stated that the high water mark as applied to tidal waters generally means the line marked by the periodic flow of the tide, excluding the advance of the water caused by winds, storms and unusual conditions. The court held that there is no valid reason for giving the term high water mark any other meaning when used to describe a boundary of a school district. (Batchelor-Fla) W69-01371

# ARNOLD V ELLIS )INJUNCTION AGAINST RAISING THE LEVEL OF A POND(, 5 Mich App 101; 145 N W 2d 822 (1966).

Descriptors: \*Michigan, \*Remedies, Legal aspects, Adjudication procedure, \*Flooding, \*Boundary disputes, Ponds, Administrative agencies, Dams, Dikes.

Plaintiffs brought suit to determine boundary and to enjoin defendants from raising the level of a pond on their land thereby flooding plaintiffs' land to the west making it impassable thus depriving plaintiff's access to their northern fields. The trial court granted the injunction determining that the level of the pond should remain at 786 feet above sea level in accordance with a 1914 government survey. The court found plaintiffs entitled to equitable relief since damages would be inadequate and no great injury would be done defendants since ample electric power could be produced with a lower pond level. Construing defendant's deed the court held that defendant's boundary line was the edge of the pond plus a strip one rod wide with the pond at the 786 foot level. This court affirmed. holding that the trial court had power to set the level of the pond since the same power to set the level of the pond since the same power granted to conservation boards by the Inland Lake Level Act was merely optional and did not confer exclusive jurisdiction on those agencies mentioned. (Kahler-W69-01377

### AUGUSTA WATER DISTRICT V WHITE )CON-DEMNATION POWER OF WATER DISTRICT(. 216 A 2d 661-665 (Me 1966).

Descriptors: \*Maine, Legal aspects, Judicial decisions, Public utilities, Public utility districts, \*Eminent domain, Regulation, Administrative agencies.

The Augusta Water District, a corporation specially chartered by the Maine Legislation, seeks to have the Public Utilities Commission determine its necessity to take land of the defendants by eminent domain. The Supreme Court held that there were no geographical limitations on the district's eminent domain powers as long as the district could demonstrate the necessity of a particular chosen lo-

cation for the purpose of supplying pure water to its specified areas. (P. N. Smith-Fla) W69-01383

# BANGOR HYDRO-ELECTRIC POWER CO V FPC )HYDROELECTRIC PROJECT LICENSING(.

355 F 2d 13-14 (1 Cir 1966).

Descriptors: \*Federal Power Act, \*Hydroelectric Project Licensing, Hydroelectric plants, Water utilization, Federal Government, Water law, Navigable waters, Non-navigable waters, Legal aspects, Electric power, Electric powerplants.

The FPC antedated the petitioners license to operate a hydroelectric project on navigable waters and the petitioner asked the court to review the order. The court held that the petitioner should have applied for the license in 1938 or in the alternative should have filed a declaration of intention applicable to non-navigable waters. Since the petitioner did neither, the FPC was correct in antedating his license. (Horner-Fla) W69-01384

# OPINION OF THE JUSTICES )MINERALS ON SUBMERGED LANDS(.

216 A 2d 656-661 (Me 1966).

Descriptors: \*Maine, Riparian rights, \*Eminent domain, Legal aspects, Judicial decisions, Legislation, Beds under water, Mining, Mine drainage.

The Maine House of Representatives asked the opinion of the Maine Supreme Court as to the legality of a bill which would permit the state's lessee to construct dams on submerged state land in order to mine the minerals under the land, and would permit the state to take riparian rights of bordering landowners by eminent domain with payment of just compensation for the period during which the tidal estuary is drained. The minerals contained in the submerged lands below the low water mark are held in trust by the state for the people. Since there will be no significant impediment to navigation, the temporary damming and draining is permissible. The state's right to do so is paramount and is not subservient to objections of riparian landowners. The landowners are entitled to just compensation for the interference with their riparian rights, and the bill properly allows this. The operation is still a public use, even though it will be carried out by a lessee who pays royalties to the state. The object is the conversion of the public resources to prevent waste, and this is a means to that end. (P. N. Smith-Fla) W69-01385

# **BOTTON V STATE )PUBLIC AND RIPARIAN RIGHTS IN NOW-NAVIGABLE WATERS(.** 420 P 2d 352 (1966).

Descriptors: \*Riparian rights, \*Reasonable use, \*Washington, \*Access, Riparian land, Lakes, Nonnavigable waters, Recreation, Judicial decisions, Relative rights, Public rights, Condemnation, Fishing. Remedies.

Identifiers: \*Injunction, Remedies (Legal aspects), Police power, Damage (Legal aspects).

This was an action to enjoin the State of Washington from maintaining a public access area on a non-navigable lake. The state acquired a lot on the lake to provide access for the public for the purposes of recreation and fishing. Members of the public so admitted to the lake repeatedly trespassed on plaintiff's property, littered the lake and its shores, stole plaintiff's property, and otherwise rendered the lake undesirable for private riparian owners. The trial court granted a permanent injunction until the state condemned and paid for the plaintiff's riparian rights which the state's licensees had infringed. This court found that the state's licensees' use of the lake constituted an unreasonable use of the lake by a riparian owner. The state was not

## Field 06-WATER RESOURCES PLANNING

## Group 6E-Water Law and Institutions

required to condemn plaintiff's riparian rights, but the injunction was granted until such time as the state could come up with a plan to police the public's use of the lake. The case contains a lengthy, general discussion of private riparian rights vis-a-vis public rights in non-navigable rights.
(Kirkconnell-Fla) W69-01388

### MAYER V GRUEBER )RIPARIAN RIGHTS IN ARTIFICIAL LAKE(.

138 N W 2d 197-205 (Wis 1965).

Descriptors: \*Riparian rights, \*Ownership of beds, Lake beds, Lakes, Riparian land, Boundaries (Property), Artificial watercourses, Water law, Legal aspects.

Identifiers: Artificial lakes.

The plaintiff in the action sought an injunction to prevent the defendant from trespassing on the waters of an artificial lake. Originally, a 157 acre tract of land was owned by a gravel company and the lake in question was created when gravel was taken from the land. The company sold a 4 acre parcel of the land to the defendant. The deed described the boundary of the property as being along the bank of the lake. The company thereafter sold the remainder of the tract to the plaintiff. The court noted that presumption exists in favor of ownership of a bed of a natural stream by the owner of the bank but that no such presumption exists where an artificial body of water is concerned. They held that the purchaser of property abutting an artificial lake acquires no rights as a riparian owner by virture of land acquisition alone. Unless the vendor conveys the right to use the lake, the purchaser is precluded from either the right of access or use. (Horner-Fla) W69-01392

### WARD V HARWOOD )TITLE TO ISLANDS IN **NAVIGABLE RIVER(.**

387 SW 2d 318-321 (Ark 1965).

Descriptors: \*Arkansas, \*Legislation, \*Islands, Accretion, Real property, Navigable waters, State government, Water law, Legal aspects, Riparian land, Riparian rights.

The question involves the construction of two state statutes. The first, passed in 1901, said that all land which forms in navigable waters within the original boundaries of a former owner of land upon the stream shall belong to the former owner. The second, passed in 1917, said that all islands formed in navigable streams belonged to the State and set forth the procedure whereby the land commissioner might have the island surveyed and sold. The court held that the 1917 act did not repeal the 1901 act. It construed the 1917 act as saying, in effect, that in all cases where islands are formed in navigable waters and not within the boundary lines of former owners, then the state may sell the island. (Horner-Fla) W69-01396

### WATER QUALITY AND RESOURCES ALLO-CATION BY PRIVATE MARKETS,

Resources for the Future, Inc. For primary bibliographic entry see Field 06B. For abstract, see . W69-01401

**EVALUATION OF THE LEGAL INSTITUTIONS** OF DIVERSION, TRANSFER, STORAGE, AND DISTRIBUTION OF WATER IN KENTUCKY,

Kentucky Univ, Lexington. A. Dan Tarlock.

Research Report 15, Kentucky Water Resources Institute, Lexington Kentucky, 1968. 111 p.

Descriptors: Legislation, Legal aspects, Permits, Water law, Riparian rights, Planning.

Identifiers: Kentucky Water Law, K.R.S. 151.

In 1966 Kentucky enacted a water use regulation statute which makes important modifications in the common law doctrine of riparian rights by authorizing the state to grant permits for the use of water. The permit system is primarily designed to allow the state to gather the information necessary to conduct long range planning studies. However, the permit system can also be used to apportion water among competing users. The report examined the common law of riparian rights to determine how KRS Ch. 151 had modified it and analyzed some of the legal problems which could arise in the administration of the statute. The standards for granting or denying a permit were examined in light of the purpose of Chapter 151. Important common law modifications such as the abolition of the watershed limitation were considered. The procedural rights of applicants and third parties affected by the issuance of a permit were criticized because they do not provide an adequate hearing and notice procedure. The constitutional questions raised by the failure of the Chapter expressly to protect prior vested rights were considered. The report concludes with an examination of some emerging problems caused by the increased use of the state's water for recreation. (Author) W69-01405

### SOME LEGAL PROBLEMS CONCERNING GROUND WATER MANAGEMENT, Bovay Engineers, Inc., Spokane, Wash.

Thomas R. Walenta.

Symp Amer Water Resour Ass, San Francisco, Calif, Proc Ser No 4, pp 39-48, Nov 1967. 10 p.

Descriptors: \*Ground water, \*Water laws, Aquifers, Laws, Groundwater recharge, Pollution abatement, Water pollution, Water quality, Riparian rights, Underground water storage.

Identifiers: \*Groundwater management, Groundwater mining, Adjudication procedure, Legal aspects, Prior appropriation.

The many problems connected with water and related land resources have been generated by an expanding population, with its consequent needs for water far beyond any before contemplated. Some of these problems include: (1) the need to classify all ground waters as public waters subject to regulation and control by the state; (2) determination of critical ground-water areas; (3) protection of the prior appropriator in extracting ground water from the basin or aquifer; (4) artificial recharge of ground-water areas and their use for storage purposes; (5) control and abatement of ground-water pollution and need for water quality programs; and (6) cooperation between state and Federal agencies in developing all water resources, a new form of creative Federalism. (USBR) W69-01417

### CLEAN UP OF LAKE MICHIGAN.

For primary bibliographic entry see Field 05C. For abstract, see W69-01500

### CHICAGO ACTS TO ATTACK COMBINED SEWER PROBLEM.

For primary bibliographic entry see Field 05D. For abstract, see W69-01512

### 200 POLLUTERS GET THE WORD EARLY. For primary bibliographic entry see Field 05D.

For abstract, see . W69-01513

### 6F. Nonstructural **Alternatives**

# IOWA NATURAL RESOURCES COUNCIL V VAN ZEE )FLOOD PLAIN ZONING(.

158 N W 2d 111 (1968).

Descriptors: \*Iowa, \*Flood plains, Legislation, Guiding codes, \*Flood plain zoning, Administrative agencies, \*Remedies, Permits, Construction, Eminent domain.

The Iowa Natural Resources Council instituted an action for mandatory injunctive relief as to structures constructed without a permit on dependants' land within a flood plain and also for injunction as to further construction. The lowa Supreme Court construed Chapter 455A of the 1966 Code as allowing mandatory injunction for the removal of existing buildings only where they could be shown to constitute nuisances within the definition of the statute. Injunction relief as to construction in progress or future construction could be obtained merely by showing that it was within a flood plain and proceeding without a permit. Alternatively the statute allowed removal of objectionable structures not amounting to nuisances by eminent domain proceedings. The court upheld the constutionality of the statute since the collective benefit therefrom outweighed any specific restraint. Requiring a permit was deemed no invasion of private property rights. The dissent contended that the statute allowed mandatory injunction for removal of structures constructed without a permit after the enactment of the statute since to deny it is to deny the only effective remedy for an unlawful act. (Kahle-Fla)

W69-01343

## JOHNSTON V STAPLES )LEGALITY OF WATERSHED CONSERVANCY DISTRICT(. 408 S W 2d 206 (Ky Ct App 1966).

Descriptors: \*Kentucky, \*Watershed management, Legislation, State governments, Federal government, Remedies, Adjudication procedure, Taxes, \*Drainage districts.

Plaintiffs challenged the validity of the creation of a watershed conservancy district and sought to prevent an exploratory survey to determine feasiprevent an exploratory survey to determine reasi-bility of creating such a district. After defendants moved for summary judgment plaintiffs offered to amend their complaint. The Circuit Court refused the amendment and plaintiffs appealed. The amended complaint alleged that since much of the land within the district belonged to the federal government and was not taxable as the statute creating the district provided, the district was not legally constituted and not authorized by law. The court construed the statute to mean only that pro-perty subject to taxation would be taxed and not that all property within the district would be taxed. Furthermore, since the United States Government had not complained of the inclusion of its land within the district, plaintiffs could not do so. No abuse of discretion being found in rejecting plaintiff's amended complaint, the lower court's judgment was affirmed. (Kahle-Fla) W69-01378

### SOME ECONOMIC ASPECTS OF LAND USE REGULATION,

Ford Foundation, Washington, D.C., Economic Development and Administration Program. William C. Pendleton.

In Factors in the Farmland Market, University of Illinois College of Agriculture, Special Publication No. 8, 1965, 14 p, 10 ref.

Descriptors: Land classification, Land development, Land use, \*Land management, Flood protection, Administrative agencies, \*Non-structural al-ternatives, \*Flood plain zoning, Project planning, Regulations, Economic evaluation, Local govern-ments, Decision making. Identifiers: Policy regulations, Land-use planning.

Land-use regulations relevant to local interests such as zoning, subdivision controls and building codes are analyzed. It is suggested that noneconomic considerations may outweigh the economic ones in deciding the best land use. Four types of arguments for the regulation of flood plains are discussed and criticized. These arguments state that controls of flood plain lands are necessary to protect other land owners or users, the land user against himself, public agencies, and future generations against present land users. Only the first of these is supported. The next is rejected because of its interference with individual freedom, and the third due to the relatively low cost incurred by relief, emergency evacuation, etc., especially when a flood insurance program is used. In order to benefit from the use of the flood plain two approaches are considered; imposing of land use regulations which will protect third parties; and balancing social cost and private gain. While a zon-ing agency is suggested, it is emphasized that the private sector can make many decisions for itself. Public intervention is considered justifiable in forcing individuals to act without anticipating relief, pay a pre-payment levy for relief, or carry flood insurance. (Richmond-Chicago) W69-01403

# 6G. Ecologic Impact of Water Development

PARTITIONING OF THE ESTUARINE ENVIRONMENT OF TWO SPECIES OF CANCER, Rhode Island University, Graduate School of Oceanography.
H. P. Jeffries.

PHS Grants WP-0002 and WP-00858, Ecology, Vol 47, No 3, pp 477-481, 1966. 5 p, 5 fig, 2 tab, 20 ref

Descriptors: Distribution, \*Crabs, \*Population, Chemical analysis, \*Spatial distribution, Fish physiology, Temporal distribution, Bibliographies. Identifiers: \*Rock crabs.

There is little mixing of Cancer irroratus and Cancer borealis populations in Narragansett Bay, R.I. Cancer irroratus is found on sand, and C borealis occurs in areas of coarse gravel and mixed rocky debris. The morphology, walking ability and serum of these crabs were examined to explain their separation in the bay. (S. Mayer-FWPCA) W69-01241

# INTERNAL CONDITIONS OF A DIMINISHING BLUE CRAB POPULATION )CALLINECTES SABIDLIS

Rhode Island University, Graduate School of Oceanography.

H. P. Jeffries. PHS Grants WP-00023 and WP-00858, Chesapeake Science, Vol 7, No 3, pp 164-170, 1966. 7 p, 2 fig, 1 tab, 19 ref.

Descriptors: \*Crabs, Population, Fish management, Fish physiology, Chemical analysis,

Bibliographies. Identifiers: \*Blue crabs.

Abundance of the blue crab, Callinectes sapidus, in Rhode Island estuaries has decreased during the last 30 years. A commercial fishery once existed in areas where the blue crab is no longer found. Composition of the plasma and muscle was studied to see if abnormalities could be recognized. Mean concentrations of total sugars, protein, non-protein nitrogen, phosphate, and chloride did not differ in crabs from two contrasting lagoons; the mean concentrations of lipids and total nitrogen were also independent of the populations's habitat. The concentration of sugars was atypically low compared with reports on crabs from North Carolina. In the plasma, total sugar concentration was directly related to its conductivity; the concentrations of non-protein nitrogen and phosphate were inversely re-

lated to chlorinity. Groups of such correlated tests have predictive value and, when further elaborated, they might be applied to the management of the fishery. This investigation was supported by Public Health Service grants WP-00023 and WP-00858. (S. Mayer-FWPCA) W69-01242

# AN INVENTORY AND STUDY OF BEAVER IMPOUNDED WATER IN MISSISSIPPI,

Mississippi State Univ., State College.
Dale H. Arner, James Baker, and David Wesley.
Water Resour Res Inst, July 1967. 49 p, 22 fig, 13
ref. OWRR Project A-009-Miss.

Descriptors: \*Beavers, \*Ponds, Surface waters, Limnology, Ecology, Fish populations, Trees, Mississippi, Soil chemistry, Water supply, Water table. Identifiers: \*Beaver ponds.

A survey in Miss. has revealed that there are 956 beaver ponds containing 23,673 acres of water. Limnological and ecological studies of randomly selected beaver ponds and feeder streams showed that 58.1% of these ponds had areas suitable for growing duck food. The dry weight of aquatic invertebrates was higher in beaver ponds than in feeder streams. Soil chemistry studies showed a buildup in beaver ponds of phosphate, potassium, and organic matter greater than in feeder streams. Fish population studies indicated there were more game fish in beaver ponds than in feeder streams. Tree damage caused by beavers was estimated at 9.6 cords per acre. A sportsmen and landowners survey in Miss. showed that there was significant interest in developing and leasing beaver ponds for recreational use. W69-01248

### INTERPRETING THE 1951 RIVERS POLLU-TION PREVENTION ACT,

For primary bibliographic entry see Field 05G. For abstract, see . W69-01527

### 07. RESOURCES DATA

### 7A. Network Design

# GOVERNOR AND COUNCIL TO REPRESENT COMMONWEALTH IN U S GOVERNMENT

State of Massachusetts, Boston.

Mass Ann Laws Ch 6, Sec 9 (1967). 1 p.

Descriptors: \*Massachusetts, \*Legislation, \*Federal government, \*Surveys, Harbors, Rivers, Shores, State governments.

The governor and his council are directed to cooperate in behalf of the commonwealth in all scientific surveys made by the U S government of harbors, rivers, shores or waters within the commonwealth. They are further directed to represent the commonwealth in relation to such surveys and to protect its interests. (Watson-Fla) W69-01294

### ASCE'S URBAN WATER STUDIES. ASCE - San Eng Div, Newsletter, p 1, July 1968.

Descriptors: \*Design, \*Storm drainage, Data collections, Instrumentation, \*Rainfall-runoff relationships, \*Water quality, Model studies. Identifiers: \*Urban drainage, \*Urban hydrology, Storage tanks.

ASCE has initiated a study program on urban hydrology consisting of two projects. 'An Analysis of National Basic Information Needs in Urban Hydrology' is a study to determine the kinds of data needed to improve the design of an urban area's storm drainage facilities; needs for data-collecting

instrumentation; and appraisal of the types of networks necessary to collect adequate data. 'A Systematic Study and Development of Long-Range Programs of Urban Water Resources Research' aims to furnish guidelines for initiating and expanding a long-range study on urban water problems; conduct a state-of-the-art study of simulation methods potentially usable for analyzing urban rainfall-runoff-quality processes; and study the requirements for assessment of drainage damage and the use of storage schemes. The non-hydrologic aspects of urban water-resources research needs will also be investigated.

W69-01556

## 7B. Data Acquisition

## INDUCED ELECTRICAL POLARIZATION AND GROUNDWATER.

California University, Berkeley. For primary bibliographic entry see Field 02F. For abstract, see . W69-01235

# A SINGLE-WELL METHOD FOR DETERMINING THE DIRECTION AND VELOCITY OF FLOW OF UNDERGROUND WATERS-RESULTS OF IN-THE-FIELD INVESTIGATIONS,

Institute of Nuclear Technology and Hydrogeological Enterprise, Cracow, Poland.

Boguslawa Turkowa, Krzysztof Czauderna, and Jan Tyrala.

Atomic Energy Comm Translation 6810, 6811, pp 55-61, 1968. Translated from Nukleonika, Vol 12, No 1-2, 1967.

Descriptors: \*Groundwater flow, \*Radioactive isotopes, Wells, Ground water, \*Radiation measurement, Piezometers, Water table, Permeability, \*Tracers, Infiltration.

Identifiers: Radiometry, Flow patterns, Flow rate, \*Dilution method, Flow characteristics, Iodine isotopes, Subsurface flow.

A single-well method is presented to determine velocity and direction of underground waterflow and results of field tests. Flow measurements require that a charge of radioactive tracer of known concentration be placed in a water-filled hole. The concentration of the tracer is measured by radiometric in-hole probes as the water flows from the hole, and is proportional to the flow. Tracer-laden water moving across the drill hole and escaping through the side of the hole will build up radioactivity from the deposited tracer. The flowdirection probe is surrounded by a shield with one open slot through which radioactivity is admitted. The probe is rotated in the hole and the direction of maximum radioactivity indicates the sector on the wall of the hole where water is escaping. Measurements were made in four drill holes to test different subsurface conditions. Comparison of results shows agreement among certain tests and lack of agreement among others. The conclusion was that the investigations will supply material for further study and planning of additional tests. (USBR) W69-01411

# PERFORMANCE MONITORING OF A DEEP COFFERDAM IN SENSITIVE CLAY, James F MacLaren Ltd, Toronto, Canada.

N. D. Pappas, and D. P. Sexsmith. Can Geotech J, Vol 5, No 2, pp 80-94, May 1968. 15 p, 7 fig, 1 tab.

Descriptors: \*Cofferdams, \*Clays, \*Sheet piling, Foreign construction, \*Soil pressures, Strain gages, \*Instrumentation, Strain measurement, Ice pressures, Deflection, Struts, Liquid limits, Soil physical properties, Lateral forces, Prestressing, Excavation

Identifiers: Soil-structure interaction, Steel piles, Canada, Foreign research.

### Field 07—RESOURCES DATA

## Group 7B-Data Acquisition

A deep, steel sheet-piled, figure-eight cofferdam with circular steel wales was installed as a temporary substructure during construction of the City of Ottawa Pollution Control Center Project. The soil profile consisted of 90 ft of a very sensitive stiff clay layer overlying 10 ft of till over the bedrock. Typical soil properties are given, the most significant being that the moisture content of the clay at lower levels is above the liquid limit. A lateral pressure of 4000 lb/sq ft applied uniformly from top to bottom was selected for the cofferdam. An attempt was made to measure axial deformation of the struts and lateral deflection of the sheet piling. Whittemore mechanical strain gages were used to measure the axial deflection of the 24WF100 struts. Duplicate readings within three to four scale divisions (1 division equals a stress increment of 150 lb/sq in.) were possible after several months. Wilson Slope Indicator gages were unsuccessful in indicating lateral deflection of the steel piling. Plots of soil pressure inferred from strain measurements vs death for various levels of excavation are given. Excessive pressure created by the ice lens in the exposed sheeting was detected by the instrumenta-tion. (USBR) W69-01413

## SONAR TOOL SURVEYS UNDERGROUND CAVITIES,

Prakla Gmbh, Hannover, W. Germany. For primary bibliographic entry see Field 08E. For abstract, see . W69-01449

### THE DEVELOPMENT OF SEISMIC OBSERVA-TIONS AND APPARATUS IN THE USSR,

E. S. Borisevich, D. P. Kirnos, and D. A. Kharin. Phys Solid Earth, No 11, pp 728-734, Nov 1967. 7 p, 2 fig, 31 ref.

Descriptors: \*Seismology, \*Earthquakes, \*Seismographs, Seismic waves, Tsunamies, Geophysics, Reviews, Instrumentation, Recording systems, Data processing systems, Seismic design, Oscillographs, Bibliographies, Measuring instruments. Identifiers: Epicenters, Foreign research, Earthquake focus, USSR, Earthquake zones.

The improvement of seismic instrumentation and capabilities in the USSR in the last 50 yr is reviewed. Earthquake studies in Russia began in the second half of the 19th century, and a Permanent Central Seismic Commission was formed in 1900. Eighteen seismic stations had been established and 4000 earthquakes recorded by 1908. Epicenters could not be located because of the unsatisfactory quality of the equipment and seismograms. Seismology in Russia was improved from 1902-1906 by Academician B B Golitsyn and associates. Under the Soviet government the range of observations and the arsenal of instrumental equipment required have increased greatly in quality and quantity and have contributed to the present high level of seismology in Russia. The development of tsunami warning stations in the Kuril Islands is of particular interest. These are arranged so that the location of an earthquake and its magnitude can be quickly determined and, in case of tsunami danger, warnings can be sent to settlements that might be threatened. (USBR) W69-01461

# DETENTION AND PREVENTION OF FOUNDATION UPLIFT FROM PRESSURE GROUTING,

Resources Agency, Sacramento, Calif. For primary bibliographic entry see Field 08F. For abstract, see W69-01463

## ENVIRONMENTAL ANALYSIS AND REMOTE SENSING,

Cold Regions Research and Engineering Laboratory, Hanover, N. H.
For primary bibliographic entry see Field 06D.
For abstract, see .
W69-01467

# LABORATORY EVALUATION OF SELECTED RADIOISOTOPES AS GROUND-WATER TRACERS.

Texas A and M Univ, College Station, Texas. For primary bibliographic entry see Field 02F. For abstract, see . W60 01401

## 08. ENGINEERING WORKS

### 8A. Structures

# SEC 137 RAISING WATER SO AS TO INJURE MILL-SEC 138 INJURY TO DAM, RESERVOIR, ETC.

State of Massachusetts, Boston. For primary bibliographic entry see Field 04A. For abstract, see . W69-01290

## ECONOMIC DERIVATION OF RESERVOIR OPERATING RULES,

Kentucky Univ, Lexington, Civil Eng Dept. For primary bibliographic entry see Field 06B. For abstract, see. W69-01406

## STRESSES AGAINST UNDERGROUND STRUCTURAL CYLINDERS,

Massachusetts Institute of Technology, Cambridge. Kaare Hoeg.

Proc Amer Soc Civ Eng, J Soil Mech Found Div, Vol 94, No SM4, pp 833-858, July 1968. 26 p, 14 fig, 4 tab, 16 ref, 3 append.

Descriptors: Stress distribution, Culverts, \*Underground structures, Pipes, Cylindrical shells, \*Soil pressures, Lateral forces, Flexibility, Bending moments, Elastic theory, Sands, Flexible tubing, Soil mechanics, Mathematical analysis, Structural behavior, Laboratory tests, \*Pressure distribution, Models, Bibliographies.

Models, Bibliographies.
Identifiers: \*Soil-structure interaction, Pipe bedding, Plane strain, Pipe tests.

The magnitude and distribution of static normal soil stresses against underground structural cylinders are studied. Results of laboratory tests on 4.5in.-dia cylinders buried in dry sand are presented. Test cylinders were split into longitudinal segments, and the force acting on each 30-deg arc of the soil-structure interface was measured. The experimental program included buried cylinders varying from almost perfectly rigid to flexible, encased in sheets of foam rubber. Analytical solutions for contact pressures and deformations are expressed by two nondimensional stiffness parameters relating flexibility and compressibility of the structural cylinder to the compressibility of a solid soil cylinder. For a perfectly rigid cylinder buried deeper than one cylinder diameter, the crown pressure is approximately 1.5 times the applied vertical pressure and the side pressure is 0.25 times the applied vertical pressure, independent of the soil modulus. The crown pressure will be approximate-ly 0.7 times applied vertical pressure and the side pressure will be approximately 0.9 times applied vertical pressure after the flexibility ratio has exceeded a certain magnitude. (USBR) W69-01421

# COMPARISON OF ANALYTICAL AND STRUCTURAL BEHAVIOR RESULTS FOR FLAMING GORGE DAM.

Bureau of Reclamation, Denver, Colo

Bur Reclam Res Rep No 14, 1968. 21p, 12 fig, 4 tab, 11 ref.

Descriptors: \*Arch dams, \*Concrete dams, Stress analysis, Deflection, Dam design, Instrumentation, Strain measurement, Computers, Temperature, Measuring instruments, Thermal stress, Data collection systems, Creep, \*Structural behavior, Plumblines, Elasticity modulus, Dams.

Identifiers: Flaming Gorge Dam (Utah), Utah, \*Trial-load method.

Efficacy of the trial-load method and reliability of assumptions used in the design and analysis of concrete arch dams can best be demonstrated by comparing analytical results with deflections and stresses from structural behavior measurements for an existing dam. Instruments that indicate length change, temperature, and deflection were installed in Flaming Gorge Dam; readings were recorded at scheduled intervals. An electronic computer was used to reduce the data to stresses, temperatures, and deflections. Stress and deflection changes were determined for 2 incremental loadings. Changes from Oct 9, 1963, to Mar 26, 1964, show the effects of seasonal temperature variation. Reservoir water and tailwater levels remained essentially constant during this period. Changes from Mar 26, 1964, to Mar 6, 1966, are the effects of a rise in reservoir water level. Average concrete tempera-tures were approximately the same for both dates; the tailwater level remained constant over the entire period. Trial-load analyses were made for the same incremental loadings, using an electronic computer. Comparisons of stress and deflection changes for each loading increment are presented. Agreement between analytical studies by the trialload method and structural behavior results is very close. (USBR) W69-01441

### **DESIGN STUDIES OF IDIKKI ARCH DAM,** Central Water and Power Commission, India.

L. V. Kunar, and C. S. Jain. Indian J Power River Val Develop, Vol 18, No 4, pp 136-148, Apr 1968. 10 p, 5 fig, 3 photo, 5 tab.

Descriptors: \*Arch dams, Concrete dams, Underground powerplants, Model tests, Elastic deformation, Mass concrete, Tunnels, \*Dam design, Joints, Dam foundations, Mapping, Aerial photography, Foreign projects, Geologic investigations, Preliminary investigations, Seismic investigations, Design criteria, Structural models, Gneisses. Identifiers: In situ tests, India, \*Idikki Dam (India).

The Idikki Hydroelectric Project in the Periyar Valley of Kerala State, India, contains a large reservoir formed by 3 dams. Water will be diverted into an adjacent basin by a 6480-ft power tunnel, 2 pressure shafts 3300 ft long, and the tailrace tunnel. There is an underground powerplant with 6 units of 130 MW. With an average head of 2181 ft and a continuous draft of 1440 cu ft/sec, the units can generate 780 MW of power at about a 30% load factor. A survey for locating the tunnel and penstocks was made by aerial photography. The foundation investigation included tests on cores and in situ dynamic tests by ultrasonic and seismic methods. The foundation at the Idikki damsite is composed of tightly foliated gneisses with bands of charnokites and is traversed by innumerable joints. Bureau of Reclamation design criteria were generally used for the arch dam. The preliminary design analysis used the crown cantilever method in which the total load was assumed to be distributed between the cantilever and arches. Structural model tests considering only the effect of water load were performed in the CWPRS Laboratory, Poona. (USBR) W69-01442

# SURVEY CONTROL FOR CONCRETE DAM CONSTRUCTION,

Bureau of Reclamation, Montrose, Colo. For primary bibliographic entry see Field 06B. For abstract, see . W69-01457

### 8B. Hydraulics

OPTIMUM PENSTOCK DIAMETER FOR HYDROELECTRIC POWERPLANTS AND PUMPING PLANTS,

California State Department of Water Resources, Sacramento.

### Hydraulic Machinery—Group 8C

For primary bibliographic entry see Field 06B For abstract, see W69-01431

### 8C. Hydraulic Machinery

CONTRIBUTION TO THE OPTIMIZATION OF SYSTEM OPERATION BY THE CHOICE OF SUITABLE METHODS OF CALCULATION FOR TRANSIENT STABILITY,
Dresden Technical Univ, Germany

K. D. Wessnigk, H. Koettnitz, and H. Schulze.

Int Conf Large High Tension Elec Syst, Paris, France, June 1968. Pap 32-11, 9 p, 7 ref, 7 append.

Descriptors: \*Transients, Operations, Calculations, Computers, Errors, Electric power, Transmission (Electrical), Optimum use, \*Power system operations, Electrical networks, Voltage regulators, Electric potential, Faults (Electrical), \*Electrical stability, Disturbances.

Identifiers: Liapunov Theorem, \*System stability (Elect), Synchronous machines, Foreign research,

Germany, Switching surges.

The behavior of faults must be considered when planning a system, determining optimum operation, or optimizing a power system by process-control. Transient stability loss is a serious disturbance that can be avoided through proper interpretation of previous calculations and corresponding corrective action. Digital, hybrid, and analog computers can be used for these calculations. Important factors in transient stability calculations include saliency effects, voltage and power regulation, damping, transient characteristic curves of the load, resynchronization, and in special cases the probability for synchronous operation of single units. Reasons for transient instability include faults, switching loads, and network changes. Transient stability is treated by calculating the steady state and initial values, setting up equations of motion of machines, and solving these equations. Methods of solution are discussed. Limitations of computer application and influencing factors are considered. For each calculation, the main points to be considered are given, independently from the method used. (USBR) W69-01414

## EFFECT OF INCREASING THE GENERATING UNIT SIZE ON SYSTEM INTERCONNECTION TIE LINES, Hungarian Power Pool; Office for Power Station

and Network Design, Budapest, Hungary.
A. O. Kerenyi, F. Ronkay, and J. Peto.
Int Conf Large High Tension Elec Syst, Paris,
France, June 1968. Pap 32-06, 14 p, 7 fig, 5 tab, 2 ref, append

Descriptors: \*Power system operations, Electric power, Electric power costs, \*Transmission (Electrical), Electrical networks, Benefits, Power O+M, Probability, Electric generators, Computation, Economics, Electric power demand, Electric

power production. Identifiers: Spinning reserve, \*Tie lines, Interties, Hungary, Foreign research, Outages, \*Intercon-

nected systems, Gaussian distribution.

The effect of large-size generating units on the transmission capacity of interconnecting tielines is investigated. The following aspects are considered: (1) benefits to the national economy resulting from the interconnection of systems; (2) transmission capacity of interconnections permitting maximum utilization of economic benefits resulting from intersystem cooperation, (3) the required economical spinning reserve, and (4) the means necessary within the interconnected systems to ensure service continuity. A hypothetical system demonstrated the effects of unit size on the capacity of interconnecting tielines. A static and dynamic method is proposed for determining the benefits of interconnection of power systems, regarding emergency help, economical load dispatching, and establishing a system development policy. The problem of economical spinning reserve is considered, and a

survey of measures ensuring service continuity of integrated systems is given. An algorithm is presented for computing the histogram of power between interconnected systems. exchange (LISBR) W69-01416

DETERMINATION OF POWER TRANSFER CAPABILITY OF TRANSMISSION SYSTEMS AND TIE-LINES ON THE OCCURRENCE OF SEVERE DISTURBANCES,

Swedish State Power Board, Stockholm

A. Olwegard, and P. Langer. Int Conf Large High Tension Elec Syst, Paris, France, June 1968. Pap 32-04, 10 p, 9 fig, 3 ref.

Descriptors: \*Electrical networks, Electrical stability, Transmission lines, Computers, \*Transmission (Electrical), \*Disturbances, Extra high voltage, Field tests, Computer programming, Hydroelectric power, Stress, Voltage regulators, Electric power, Excitation, Thermal power, \*Faults (Electrical), Transients, Electric power failures. Identifiers: \*Tie lines, \*Interconnected systems, \*Power system stability, Spinning reserve, Sweden, Foreign research, Power grids.

Loss of large generators or tripping of heavily loaded transmission lines momentarily results in transient stresses on a network that may be less than those occurring after transient line faults with rapid disconnection and autoreclosing. Tripping of generators or lines may set up such severe undamped swings on the system that some synchronous machines will fall out of synchronism and eventually in chain reaction lead to a complete breakdown. Line tripping and loss of large power units may be among the factors most important for stability. The steady state stability after the fault, and the transition from transient to steady state conditions become decisive factors. Investigations are important to determine how the transmission capacity is affected by such factors as design of power-frequency regulation equipment, load characteristics, and voltage regulation. Two methods of calculating the dynamic behavior of the system are compared with field tests of the transmission capacity of a tieline connecting a Norwegian 130-kv network with the Swedish network. W69-01418

### OPTIMISATION IN THE USE OF THE MEANS OF PRODUCTION AND TRANSMISSION

For primary bibliographic entry see Field 06B. For abstract, see W69-01422

## PLANNING OF 735 KV EXTENSION TO HYDRO-QUEBEC SYSTEM TO INCORPORATE CHURCHILL FALLS IN 3300 MILE NET-

R. Fournier, D. McGillis, and J. C. Roy. Int Conf Large High Tension Elec Syst, Paris, France, June 1968. Pap 42-02, 8 p, 6 fig, 1 tab, 9

Descriptors: \*Extra high voltage, Alternating currents, Electric power production, \*Transmission lines, Direct currents, Economics, Technology, Transmission (Electrical), Losses, Electric power, Electrical stability, Hydroelectric power, Electric insulation, Foreign construction, Bundled conductors, Extra long distance, Costs, Foreign projects. Identifiers: Churchill Falls Pwrplt (Canada), Hydro-Quebec (Canada), Switching surges, Per-

The Churchill Falls Development, located 800 mi northeast of Montreal, will generate 5000 mw and 30 billion kwh of power. Transmission of this power has been studied extensively by Hydro-Quebec. The reliability of ehv a-c transmission is discussed from experiences available after 2 operation of the Hydro-Quebec 735-kv network The possibilities of hvdc transmission are investigated. Application of these 2 technologies to Churchill Falls is made by technical and economic comparisons. Results apply only to the particular problem, but general trends in ehv transmission are indicated. Studies made by Hydro-Quebec in selecting the transmission system from Churchill Falls to Montreal are discussed. The extension of the Hydro-Quebec network to incorporate Churchill Falls presented a choice of extending the use of 735-kv a-c transmission or embarking on hvdc transmission. This paper assesses the possibilities of a-c and d-c transmission; while the analysis concerns Churchill Falls problems, the main objective is to evaluate the future of ehv transmission. (USBR) W69-01424

## INSULATION CO-ORDINATION IN EHV SYSTEMS WITH LOW INSULATION LEVELS --A SURGE DIVERTER PROBLEM,

Inst Eng, Aust, Elec Eng Trans, Vol EE4, No 1, pp 31-36, Mar 1968. 6 p, 7 fig, 2 tab, 10 ref, disc.

Descriptors: \*Extra high voltage, \*Electric insulation, \*Coordination, Lightning, Circuit breakers, Alternating currents, Resistors, Electrical net-works, Capacitors, Computers, Electrical equipment, Stress, Foreign countries, Power transformers, \*Surges.

Identifiers: \*Switching surges, \*Surge diverters, \*Overvoltage, Basic impulse level, \*Protection (Electrical), Sweden, Electrical insulators.

Insulation coordination is a problem in ehv systems with low insulation levels because of the comparatively low insulation withstand strength against switching overvoltages. An application philosophy for surge diverters is outlined, in which a distinction is made between surge diverters used only for protection against lightning overvoltages and those used also for protection against switching overvoltages. The choice of suitable sparkover characteristics and discharge abilities of surge diverters is discussed. A flat sparkover characteristic is desirable when the surge diverter is used for protection against all types of overvoltage. A computer study of the phenomena occurring with line switching shows that a surge diverter with a low sparkover voltage must be able to handle repeated discharges with high energy contents. (USBR) W69-01426

## FUNDAMENTALS OF HVDC INTERRUPTION,

Electra--CIGRE, No 5, pp 24-38, June 1968. 15 p,

Descriptors: \*Extra high voltage, Energy, \*Direct currents, Resistors, Electric currents, Inductance, Magnetic induction, Electric insulation, \*Circuit breakers, Faults (Electrical), Electric potential, Dielectrics, Bibliographies, Extra long distance, Capacitance, Rectifiers, Control systems, Capaci-

Identifiers: \*Switching surges, \*Overvoltage, Short circuits, Sweden, Foreign research, Switching.

Various switching operations that may be expected when breaking devices are applied to hvdc transmission show 6 typical cases: (1) clearance of faults close to the converter station, (2) clearance of faults at a remote point on the transmission line, (3) interruption of load currents without transmission line, (4) interruption of load currents with transmission line, (5) interruption of load currents on parallel lines, and (6) switching of lines under no-load conditions. The first 5 methods of d-c interruption and their reaction on a circuit breaker are studied, using an equivalent circuit. The sixth method does not present any major problem in d-c interruption. HVDC transmissions now in service are operated in conjunction with special currentcontrol systems, and short-circuit fault currents are limited to values not much in excess of normal load currents. The amount of magnetic energy in the circuit will be about the same for normal load and

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### Group 8C—Hydraulic Machinery

short-circuit fault currents. The magnetic energy of the system will increase with higher currents and longer lines; energy released in the breaker will depend on the switching voltage and the type of current control used. (USBR) W69-01428

### STUDY OF OVERHEAD GROUND WIRES FOR DC TRANSMISSION LINES,

Cairo Univ., Giza, Egypt Mohamed M. Khalifa. Inst Elec Electron Eng Trans Power App Syst, Vol PAS-87, No 7, pp 1648-1656, July 1968. 9 p, 7 fig, 2 tab. 1 ref, disc

Descriptors: \*Direct currents, Transmission lines, Descriptors: \*Direct currents, Transmission lines, Interference, Field tests, \*Electrical coronas, \*Radio interference, Telephones, \*Electrical grounding, Laboratory tests, Instrumentation, Measurement, Ionization, Energy losses, Models, Losses, Electric currents, Electrical engineering. Identifiers: \*Overhead ground wire, Bipolar transmission lines, United Arab Republic, Test results, Foreign research, Induced voltage.

Experimental and calculated results are presented of a study on the influence of overhead ground wires on corona losses, radio interference (RI), and telephone interference of d-c lines. Corona losses and RI were measured on a full-scale bipolar test line. Corona losses were measured on laboratory models of monopolar, homopolar, and bipolar lines. Telephone interference levels were obtained by computer. Ground wires cause a considerable increase in corona losses of monopolar and homopolar d-c lines. Two ground wires on a bipolar d-c line cause a significant increase in corona losses only at voltage gradients close to the inception level, and cause a reduction in RI at higher voltages. Insulated ground wires have no significant effect on corona losses on d-c lines, but acquire voltages that may reach a considerable percentage of the line voltage. Ground wires above the high-voltage conductors of d-c lines raise the interference level in adjacent telephone circuits; the effect is slight at locations near line terminals. (USBR) W69-01432

### NEW DEVELOPMENTS IN HIGH-VOLTAGE MINIMUM OIL CIRCUIT BREAKERS,

Micafil Ltd., Zurich, Switzerland

Urs P. Gugelmann. Inst Elec Electron Eng Trans Power App Syst, Vol PAS-87, No 7, pp 1613-1622, July 1968. 10 p, 12 fig, 2 tab, 4 ref, disc.

Descriptors: \*Circuit breakers, Interrupters, Electric power, Electric currents, Design, \*Electrical equipment, Resistors, Field tests, Faults (Electrical), Test procedures, Hydraulic systems, High pressures, Power O and M, Reliability. Identifiers: Insulating oil, Foreign research, Switzerland, Oerlikon Eng. Co. (Zurich).

A new restrike-free, fast-acting, minimum oil circuit breaker for the 60- to 500-kv range is described. The breaker can be equipped with inter-rupters for either 40,000 or 60,000 amp, providing a maximum symmetrical interrupting capacity of 50,000 mva. The modular-type breaker is built from self-contained, identical, and interchangeable basic building elements. The breaker is practically noiseless, has vibration-free operation, has a reliable drive precluding any undue action, and is fast and simple to erect and maintain. Arcing time is independent of the interrupted current because of an effective oil injection system. Fully hydraulic operation of the contacts eliminates the use of mechanical transmission and springs. Test results confirm that the breaker's performance exceeds standard requirements; it is insensitive to high rates of recovery voltage. (USBR) W69-01433

TOKYO'S OUTER LOOP SYSTEM, Tokyo Electric Power Co., Inc., Japan. Ichiro Hori.

Energy Int, Vol 5, No 8, pp 12-15, Aug 1968. 4 p, 4 fig, 1 tab.

Descriptors: \*Extra high voltage, Electric power, Reliability, Safety, Power system operations, Foreign construction, Distribution, Planning, Electric power demand, Electric power production, Thermal power, Thermal powerplants, Coordination, \*Transmission (Electrical), Pumped storage, Hydroelectric power, Transmission lines. Identifiers: Japan, \*Electrical design, \*Intercon-

nected systems, Load centers, Underground cables,

This paper discusses progress being made by the Tokyo Electric Power Co. for modernizing power supply facilities in Tokyo to meet the predicted expansion in consumer demand. Since 1960, the 275ky outer loop system has been strengthened by making it a double-circuit system functioning as a ring surrounding the load center in Tokyo. The voltage of this system will be raised to 500-kv operation to match voltage on the trunk lines as their voltages are increased to meet demand. The ehv system will be extended into the center of Tokyo through 275-kv underground cables. A 300mw d-c frequency converter station has been installed, making it possible to interconnect the 50-cycle Nagoya loop with the 60-cycle Tokyo loop for coordinated operation and improved system reliability. The outer loop system permits time diversity of different loads and waterflow diversity of different rivers to be used effectively for economic operation of the overall systems of the company. W69-01435

### **BULGARIA'S HYDRO-POWER POTENTIAL,**

For primary bibliographic entry see Field 06B. For abstract, see . W69-01451

### THE SENECA PUMPED-STORAGE PLANT,

Cleveland Electric Illuminating Co., Ohio. Seymour B. Rock

Proc Amer Power Conf, Vol 29, pp 720-730, 1967. 11 p, 8 fig, 3 ref.

Descriptors: \*Pumped storage, \*Hydroelectric powerplants, Draft tubes, Planning, Reservoirs, Design data, Intake structures, Penstocks, Optimum design, Pressure pipes, Conduits, Asphaltic concrete, \*Pump turbines, Hydraulic turbines, Electric generators

Identifiers: Pennsylvania, \*Seneca Pump Storage Plt (Pa), Synchronous machines.

The 3-unit Seneca Pumped Storage Plant on the Allegheny River about 200 mi upstream from Pittsburgh, Pa., will have a rated capacity of 380,000 kw and is scheduled for service in mid-1969. Power facilities are being installed adjacent to the concrete-earthfill Kinzua Dam constructed by the Corps of Engineers. The floor of the upper reservoir, located on a plateau adjacent to the left abutment of the dam, will be about 700 ft above the water level behind the dam and 800 ft above the elevation of the river below the dam. Phases of the work discussed include: (1) planning considerations; (2) plant description; (3) design highlights, including synchronous starting, a divided draft tube, and an asphaltlined upper reservoir; and (4) optimizing plant design. The Pennsylvania Electric Co and The Cleveland Electric Illuminating Co made the planning studies; Harza Engineering Co performed engineering and construction manage-ment services. (USBR) W69-01454

## **EVALUATION OF HARMONIC LEVELS ON AN** HVDC TRANSMISSION LINE, Allis-Chalmers, Milwaukee, Wis; University of

Wisconsin, Madison.
D. H. Welle, A. G. Phadke, and D. K. Reitan.
Proc Amer Power Conf. Vol 29, pp 1100-1108,

1967. 9 p, 6 fig, 7 ref, append.

Descriptors: \*Direct currents, \*Extra high voltage, Waves, Rectifiers, Transmission lines, Converters (Electrical), \*Interference, Attenuation, Graphical analysis, Analysis, Filters (Electromagnetic), Electric power, Resonance, Disturbances.

Identifiers: \*Evaluation, \*Harmonics, Propagation, Interties

Using symmetrical components, the author discusses a convenient means of analyzing har-monic levels occurring on d-c transmission lines. The valve element of an hvdc converter functions as a switch, opening and closing in a predetermined sequence, and creating cyclic disturbances on the d-c system. Voltage discontinuities appearing on the output d-c voltage can create harmonic content in excess of 10 to 15%. An analysis based on the concept of steady-state traveling waves provides an insight into factors influencing harmonic levels and is useful in designing filters for d-c transmission lines. A normalized graph aids in determining the harmonic variation along the transmission line. Equations for computing the harmonic level along the line and a method of deriving the normalized graph are given. (USBR) W69-01455

## HIGH-VOLTAGE CIRCUIT BREAKERS WITH SWITCHING RESISTORS AND HIGH CURRENT RATINGS,

Allis-Chalmers, Boston, Mass.

L. A. Holden.

Proc Amer Power Conf, Vol 29, pp 1118-1125, 1967. 8 p, 8 fig, 1 tab, 4 ref.

Descriptors: Extra high voltage, \*Circuit breakers, Electric currents, \*Resistors, Surges, Transients, Electric power, Capacitance, Electrical equipment, Faults (Electrical), Oscillation, Transmission lines, Design, Electric insulation, \*Interrupters, Reviews, Damping.

Identifiers: \*Switching, \*Switching surges, Current rating, Flashover, Overvoltage.

During the past 5 yr the electric power industry has made greater use of extra high voltage (345 and 500 kv) to transmit large blocks of power over extra long distances. There are 2 requirements of ehv system operation that can impose new capability requirements on circuit breakers for use in highvoltage systems operating in conjunction with ehv lines, either at the source or at load terminals. These are: (1) control of ehv line voltage surges on closing of low-side circuit breakers switching ehv lines on the low-voltage side of a transformer, and (2) continuous current ratings up to 3000 or 4000 amp to carry load currents associated with ehv line loadings. This paper reviews the general usage of resistors in circuit breakers, and through definition of the functions of various ohmic values of resistors used, introduces the application of surge control resistors in oil circuit breakers for low-side switching of ehv lines. A description is given of the development of breakers in the 115- and 138-kv class with continuous current ratings up to 4000 amp for carrying kva loads corresponding with ehv line capabilities. (USBR)

### GIANT-SIZED HYDRAULIC TURBINES,

Bechtel Corp., San Francisco, Calif.; Acres Ltd., Toronto, Canada.

J. L. Haydock, and J. Gavin Warnock. Amer Power Conf, Apr 1968. 36 p, 8 fig, 9 tab.

Descriptors: \*Hydraulic turbines, Pump turbines, \*Forecasting, Design, Manufacturing, Erection, Transportation, \*Reviews, Economics, Mechanical engineering, Capital costs, Technology, Fabrica-tion, Handling equipment, Foreign design prac-tices, \*Turbines, Specific speed.
Identifiers: Bulb turbines, \*Hydraulic design, Canada, Tube turbines, Foreign research.

The past 25 yr of turbine building progress is reviewed, and predictions for 1980 are considered. Important aspects in the development trends of

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hydraulic turbines that must be considered when forecasting the future include: (1) pressure applied by optimum economic development of hydropower sites; (2) advances in technology, particularly as applied to manufacturing and material techniques; and (3) function of the large hydraulic turbine in relation to power systems of the future. All facets of the economics of large hydraulic turbines that must be carefully considered are discussed. Modern technology indicates that hydraulic design will in no way limit the advance to the 2,000,000hp frontier by 1980. Tabluations are given of large hydraulic turbines in operation, under construction, or planned. Large pump-turbines and bulb and tube turbines are listed. (USBR) W69-01459

### 8D. Soil Mechanics

**CHANGES IN THE PROPERTIES OF SETTLED** LOESSIAL SOILS WITH DEPTH AFTER COM-PACTION OF THE SOILS BY WETTING AND THE EFFECTS OF BLASTING.

I. M. Litvinov

Transl from Osn Fundamenty i Mekh Gruntov, No 6, pp 24-25, 1967. Soil Mech Found Eng, No 6, pp 419-421, Nov-Dec 1967.

Descriptors: \*Soil compaction, \*Loess, Compaction tests, Soil physical properties, \*Settlement, Explosions, Soil consolidation tests, Porosity, Blasts, \*Compaction, Density, Moisture content, Soil mechanics, Foreign construction, Costs, Dynamics. Identifiers: Blasting, Soil dynamics, Soil density, Foreign research, USSR.

The author presents a method of deep compaction of settled loessial soils by wetting and then subjecting the soil to the effect of blasting. Data on changes in properties of such soils with depth before and after compaction are presented. The method makes possible reduction of the danger of wet zones, more rapid compaction, and development of greater density. A graph of the soil density after compaction in tons/cu m vs depth indicates densities of 1.4 at 1 m, 1.47 at 3 m, 1.4 at 5 m, increasing to 1.62 at 10 m, and continuing near 1.62 to 20 m. The percent porosity of the soil vs depth shows 47.5% at 1 m, 46% at 3 m, 49% at 5m, decreasing to 40% at 20 m before blasting. The porosity was 47% at 1 m after blasting and decreased to approximately 40% at 10 m. The dynamic factor (blasting) reduced the thickness of the upper uncompacted zone of settled soil at one test site from 7-9 m to 4-6 m. The approximate cost/sq m of a layer compacted to 15 m was 7 rubles, 50 kopeks (\$7.50). The method appears to be economical and reliable. (USBR)

### PERFORMANCE MONITORING OF A DEEP COFFERDAM IN SENSITIVE CLAY,

James F MacLaren Ltd, Toronto, Canada For primary bibliographic entry see Field 07B. For abstract, see . W69-01413

## COMPOSITIONAL AND ENVIRONMENTAL IN-FLUENCES ON THE STRESS-STRAIN-TIME BEHAVIOR OF SOILS,

California Univ, Berkeley. Terence J. Hirst, and James K. Mitchell. Soil Mech Bitum Mater Res Lab Rep No TE 68-4, Univ California, Berkeley, Apr 1968. 242 p, 70 fig, 10 tab, 63 ref, 3 append.

Descriptors: Clays, Cohesive soils, Compressive strength, Creep, Grain shapes, Consolidation, Failure (Mechanics), Gradation, Grain sizes, Soil structure, Kaolin, Sensitivity, Shear tests, Triaxial compression, \*Clay minerals, \*Soil texture, \*Stress-strain curves, Triaxial stress, \*Soils, Soil mechanics, Bibliographies, Time, Sands.

Identifiers: Strain rate, Compressibility, Undrained shear strength, Illite.

Influences of the clay mineral type, and the grain shape and size distribution of nonclay particles on consolidation, strength, and creep characteristics of prepared sand-silt-clay mixtures can be interpreted in terms of interactions between the clay and granular phases. The interference between clay and nonclay phases that develops during consolidation prevents either phase from consolidating to the void ratio it would attain in the absence of the other phase. The stiffness of normally consolidated mixtures varies with clay content but is essentially independent of the grain size distribution and particle shape characteristics of the granular phase. Adding granular particles to a sand-silt-clay mixture may result in increased or decreased strength at a given consolidation pressure, depending on whether the strength increase provided by the granular phase exceeds the strength reduction in the clay phase that results from the additional interference to clay consolidation caused by the granular phase Changes in undrained strength occurring during sustained loading depend on the creep stress level, duration of load application, and clay type, but are independent of the consolidation pressure and type and amount of the granular phase. (USBR)

### LANDSLIDES DURING EARTHQUAKES DUE TO SOIL LIQUEFACTION.

California Univ., Berkeley. H. Bolton Seed. Proc Amer Soc Civ Eng, J Soil Mech Found Div, Vol 94, No SM5, pp 1053-1122, Sept 1968. 70 p, 66 fig, 1 tab, 73 ref.

Descriptors: \*Earthquakes, Faults (Geology), \*Landslides, Void ratios, \*Liquefaction, Rock mechanics, Seismic waves, Seismic properties, Lenses (Soils), Bibliographies, \*Seismic investigations, Seismology, Pore water pressures, Stability analysis, Saturation, Shear strength, Sands, Pore

Identifiers: Stability, \*Slope stability, Terzaghi lecture, \*Seismic stability, Soil dynamics, Earthquake

The 4th Terzaghi lecture has 2 main objectives. First, frequency and conditions of occurrence of landslides due to soil liquefaction during earthquakes are examined. In addition to discussing individual events during particular earthquakes, a list of known slides in which liquefaction has played a part is included to evaluate the severity of the problem. A review of the list shows that the slides have been initiated by liquefaction of saturated sandy soils in a loose to medium dense condition resulting from earthquakes varying in magnitude from 5.5 to 8.5 points (Richter) and at epicentral distances of several miles to hundreds of miles. This type of slide must be seriously considered in seismically active regions. The second objective is to emphasize the importance of minor geologic and technical details in determining the occurrence and nature of landslides during earthquakes due to soil liquefactions. (USBR) W69-01438

### AN ANALYSIS OF THE SHEFFIELD DAM FAILURE,

California Univ., Berkeley and Los Angeles H. Bolton Seed, K. L. Lee, and I. M. Idriss. Soil Mech Bitum Mater Res Lab Rep No TE-68-2, Univ California, Apr 1968. 101 p, 44 fig, 2 tab, 13

Descriptors: \*Dam failures, \*Dam foundations, Embankments, Compaction, Soil stability, \*Stability analysis, \*Earth dams, \*Earthquakes, Seismic investigations, Seismic properties, Shear strength, Liquefaction, Sands, Impervious blankets, Cutoff trenches, Safety factors, Soil liquefaction, Silts, Seismic design.

Identifiers: Earthquake engineering, Earthquake damage, Soil dynamics, \*Sheffield Dam (Calif), Seismic studies, Cyclic loads, Seismic stability.

An attempt is made to reconstruct the circumstances leading to the Sheffield Dam failure during the 1925 Santa Barbara earthquake. Field observations and dynamic analyses indicate that failure was caused by liquefaction. The downstream slope failed because the upstream slope was supported by the 15- to 18-ft-deep reservoir. The 25-ft-high dam was constructed of silty sand on a foundation of similar material about 6 ft thick. The embankment was compacted by equipment travel to a relative density of about 35%. The foundation and lower portion of the embankment were saturated by seepage. The earthquake had a magnitude of about 6.3 with an epicenter located about 7 mi from the damsite. Resulting ground accelerations had a maximum amplitude of about 0.15 g, a frequency of about 3 cycles/sec, and a duration of significant shaking of 15 to 18 sec. Dynamic response analyses indicate the dam was probably subjected to a series of earthquake-induced inertia forces equivalent to 10 uniform force cycles at maximum amplitude. Cyclic-loading triaxial compression tests indicated a factor of safety of 1.15 against failure by soil liquefaction. A similar analysis using results of simple shear tests indicated a factor of safety of 0.75 and a failure surface in good agreement with the actual one. (USBR) W69-01444

## A STUDY OF PORE WATER PRESSURES DUR-ING ELECTROKINETIC TREATMENT, Cornell Univ., Ithaca, N. Y.

Melvin I. Esrig.

Soil Eng Ser Res Rep No 6, Cornell Univ, Ithaca, N Y, Mar 1968. 87p, 42 fig, 2 tab, 17 ref, append.

Descriptors: \*Pore water pressures, \*Negative pore pressures, \*Pore pressures, Consolidation, Electroosmosis, Electrophoresis, Boundaries, Soil sta-bilization, \*Electrokinetics, Electrolytes, Bibliographies, Soil physical properties, Soil mechanics, Soil chemical properties, pH, Soil consolidation tests, Ions, Permeability, Piezometers.

Identifiers: Soil water movement, Soil conductivity.

Pore water pressures in soils during electrokinetic treatment are considered on a semitheoretical basis. Results of an experimental program on problem areas are given. The work was sponsored by the US Army Materiel Command as a feasibility study of soil stabilization for military mobility. Pore water pressures in soils may be due to various causes, one being an externally applied hydraulic head. Only pressures from a potential field (transmitted to the soil through electrodes) or from physical-chemical changes in the soil are discussed. Pore water pressures in cylindrical soil samples under a uniform potential field were investigated for systems with: (1) water at one end, (2) water at both ends, and (3) both ends closed. The negative pore pressure of 5 psi was measured. Changes in pH, ion concentration, and applied voltage were interrelated and influenced pressures in soils subjected to electrokinetic treatment. Pore water pressures will develop even in a uniform field where water has access to the sample; they are related to discontinuities in pH, ion concentration, and the electric field. (USBR) W69-01464

## A FEASIBILITY STUDY OF ELECTROKINETIC PROCESSES FOR STABILIZATION OF SOILS FOR MILITARY MOBILITY PURPOSES,

Cornell Univ., Ithaca, N. Y. Melvin I. Esrig.

U S Army Eng Waterways Exp Sta Rep 4, July 1967. 86 p, 25 fig, 5 tab, 23 ref, 2 append.

Descriptors: \*Soil stabilization, \*Electrokinetics, \*Soil treatment, Montmorillonites, Quartz, Shear tests, Vane shear tests, Consolidation, strength, Electrical properties, Permeability, Electroosmosis, Clays, pH, Soil mechanics, Bibliographies.

## Field 08—ENGINEERING WORKS

## Group 8D—Soil Mechanics

Results are presented of a laboratory investigation of the effects of electrokinetic treatment on the strength of consolidated samples of illitic and montmorillonitic soils. Samples were remolded specimens of sifted illite and montmorillonite mixed with a manufactured quartz silt. Average strength increases of from 1.5 to 40 times occurred when samples were treated electrically for 96 hr. Although strength increases for montmorillonitic samples are similar in magnitude to those occurring in illitic samples, they could not be related to the clay fraction. Electrokinetic treatment is most beneficial when the ratio of energy input per unit volume of clay fraction is the greatest. This indicates that electrokinetic treatment is most useful in soils with clay contents of between 5 and 20%. The coefficient of electrokinetic permeability varied throughout the treatment period. An equation is suggested relating this coefficient to several soil index properties. (USBR) W69-01466

## 8E. Rock Mechanics **AND Geology**

SLOPE STABILITY PROGRAM OF KEN-NECOTT COPPER CORPORATION

Kennecott Copper Corp, New York, NY Carl D. Broadbent

Amer Inst Mining Eng Annu Meet, New York, Feb 1968. 31 p, 11 fig, 12 ref.

Descriptors: \*Critical slopes, \*Cut slopes, \*Land-slides, Optimum use, Stress, \*Stability analysis, Models, Materials stability, Ground water, Shear strength, Shear failures, Rock mechanics, Threedimensional, Pits, Slopes, Economics, Water pressures, Shear resistance

Identifiers: Failure surfaces, Open pit mining, Kennecot Copper Corp, \*Slope stability

The goal of slope mechanics in open pit mining is to produce efficient and safe slopes and to optimize slopes and minimize stripping by steepening the slopes to their maximum stable limit. The necott Copper Corp established a slope mechanics capability in 1956, and recent work at their Kimberly pit provides a 3-dimensional picture of stability variables. Slope failures can result from rockfalls, rotational shears, block flows, or plane shears. The location, intensity, and orientation of planes of weakness are treated separately because of their influences on slope failure. Kennecott integrates technology into a unified slope mechanics system, balancing effective slope stress and strength. Their approach is to: (1) measure or estimate-structure, strength, stress, and ground water; (2) define operating variables as ore profiles, topography and operation design; and (3) successively evaluate the stability of the most economic design slope with a stability model until the overall stability factor is secured. Slope analysis has reached a productive stage in which the cost per ton of ore for an effective program is compensated by potential savings. (USBR) W69-01412

### LANDSLIDES DURING EARTHQUAKES DUE TO SOIL LIQUEFACTION,

California Univ., Berkeley For primary bibliographic entry see Field 08D. For abstract, see W69-01438

SONAR TOOL SURVEYS UNDERGROUND CAVITIES.

Prakla Gmbh, Hannover, W. Germany Ernest Nolte

Oil Gas J, Vol 66, No 38, pp 76-78, Sept 1968. 3 p,

Descriptors: \*Sonar, Drill holes, Boreholes, Underground structures, \*Subsurface investigations. \*Surveying instruments, Acoustic equipment, Measuring instruments, Instrumentation, Engineering geology, Sonic waves, \*Soundings, Cavities, Foundation investigations. Identifiers: Probes (Instruments), \*Underground \*Underground cavities, Foreign openings, \*Underground cavities, Foreign products, West Germany, Sonic probes, Remote

A newly developed sonar probe permits complete profiling of underground cavities. The instrument is suspended on a cable, lowered into a borehole, and records horizontal and vertical cross sections for determining the volume and shape of underground cavities. The tool has a rotating and tilting head that overcomes the limitations of horizontally scanning sonar. The head may be rotated 360 deg around the axis and tilted to an angle of 90 deg for upward and downward scanning. Three sonar operating frequencies of 200, 600, and 1000 kc/sec are provided to improve scanning resolution for varying transmission and reflection conditions and distances. The 600-kc/sec frequency is commonly used for measuring distances to 300 ft. Correct depths of the cavity are measured by an electromagnetic detector that uses casing collars as reference points. The probe is 3-1/2 in. in diameter, 12 ft long, and weighs 200 lb. (USBR) W69-01449

### THE RESULTS AND OBJECTIVES OF SOVIET SEISMOLOGY )1917-1967(,

F. F. Savarenskii. Phys Solid Earth, No 11, pp 721-727, Nov 1967. 7

Descriptors: \*Seismology, \*Earthquakes, \*Seismographs, Foreign design practices, Seismic waves, Geophysics, Seismic investigations, Measuring instruments, Engineering geology, Seismic design instrumentation, Reviews.

Identifiers: Earthquake engineering, Epicenters, Earthquake zones, Earthquake focus, USSR

The objectives of Soviet seismology are: (1) planning and developing earthquake-proof structures and buildings, (2) researching foreshocks to perfect methods of predicting earthquakes, and (3) investigating the structure of the earth from seismic data. The paper discusses the steady progress of seismology in Russia before and after 1917; during the first 5-yr plans; in the postwar period; in the 1960's; and after the 1966 Tashkent earthquake. The destructive Ashkhabad earthquake in Oct 1948, initiated a period of intensive development to correct certain defects in the national system. such as the accuracy of locating epicenters and establishing the depth of foci. The earthquake demonstrated that earthquake-proof buildings, taking into account the seismic zoning, suffered only slight damage although the tremor reached 10 scale units in certain localities. The author concludes that Russia is approaching the solution of the basic problems of seismology by developing methods to predict earthquakes and design reliable and economical earthquakeproof buildings. (USBR) W69-01460

### DETERMINATION OF THE STRESS IN ROCK UNAFFECTED BY BOREHOLES OR DRIFTS. FROM MEASURED STRAINS OR DEFORMA-TIONS,

Kyoto Univ., Japan. Y. Hiramatsu, and Y. Oka. Int J Rock Mech Mining Sci, Vol 5, No 4, pp 337-353, July 1968. 17 p, 8 fig, 5 tab, 10 ref.

Descriptors: \*Stress analysis, \*Rock mechanics, \*Stress distribution, Stress, Strain, Elasticity, Boreholes, Drill holes, Strain measurement, Strain gages, Drifts, Measuring instruments, Deformation, ubsurface investigations, Tunnels. Identifiers: Borehole deformation gage, Foreign

Formulae used to quantitatively determine the state of stress in rock unaffected by boreholes or drifts are discussed. Investigations consisted of: (1) measuring variations in borehole diameters, (2)

research, Japan.

measuring strain on the bottom surface of boreholes, (3) measuring strain on the wall surface of boreholes, (4) measuring variations in boreholes in an oblique dimension, (5) combinations of the above, (6) measuring strains on the walls of drifts or shafts, and (7) using the calibration tests. The study assumed that the ground was perfectly elastic and in a general state of stress, and that the direction of the boreholes or drifts in which measurements were made could be optional. Numerical examples and a discussion of the accuracy of the first 4 procedures indicate that the highest accuracy would be secured using variations in borehole diameters. The least number of boreholes or drifts necessary for each measurement was noted. (USBR) W69-01462

### 8F. Concrete

### THE BEARING STRENGTH OF CONCRETE LOADED THROUGH RIGID PLATES,

Sydney Univ, Australia. N. M. Hawkins. Mag Concr Res, Vol 20, No 62, pp 31-40, Mar 1968. 10 p, 9 fig, 5 tab, 16 ref.

Concrete, \*Concrete Concrete structures, Failure (Mechanics), \*Bearing values, \*Bearing capacities, \*Plates, Strength of materials, Ultimate loads, Eccentric loading, Loading rate, Compressive strength, Load distribution, Bibliographies, Internal friction, Cracks, Cracking Identifiers: Concrete properties, Foreign research, \*Bearing pressure, \*Bearing strength, Australia.

Approximate expressions are developed for bearing strength of concrete members loaded through rigid plates. Ultimate strengths are reported for 18 series of tests in which effects of concentric and eccentric loading, geometry of specimen and loading plate, and type and strength of concrete were evaluated. General expressions for bearing strength are developed on the basis of failure modes observed in the tests. The majority of specimens were 6-in. cubes loaded through 3/4-in.-thick steel plates. Specimens were in direct contact with the platens of a testing machine except during eccentric loading tests when a roller system was inserted between the upper platen and bearing plate. The loading rate was approximately 30 psi/sec. Vertical cracks on the sides of the specimen closest to the loaded area were the first failure warning. Shortly after this warning, the maximum load was reached and a wedge of concrete was punched out from beneath the bearing plate. Simple failure models are proposed for concentric and eccentric loading conditions. Any increase in bearing capacity above the compressive strength of the concrete is directly dependent upon the angle of internal friction; the bearing zone should be dense and air voids and shrinkage cracks minimized. (USBR) W69-01419

#### DESIGN DIRECT METHOD PRESTRESSED CONCRETE SLABS.

Catholic University of America, Washington, D.C. Chen-Hwa Wang. J Prestressed Concr Inst, Vol 13, No 3, pp 62-72,

June 1968. 11 p, 5 fig, 6 ref, append.

Descriptors: \*Prestressed concrete, Design criteria, Concrete, \*Design tools, Design, \*Slabs, Concrete structures, Structural design, Moments, Prestressing, Compressive strength, Bending moments, Load distribution, Continuous beams, Supports, Live loads, Dead loads, Reinforced concrete, Reinforcing steel.

Identifiers: Design improvements, Design prac-

A direct design method for prestressed concrete slabs is based on the load-balancing analysis for obtaining the desired minimum or allowable maximum compressive stresses at the extreme fibers of control sections. Control sections should be selected first considering maximum moment and economy of the entire slab, then behavior of the slab under design load can be predicted. The section with maximum bending moment may be considered as the control section in a simple span. A continuous slab has several maximum moment peaks in the middle portion of spans and over supports. Therefore, selecting the control section depends on the type of structure and engineering judgment. Direct design equations for slabs under uniformly distributed loads are presented and their derivations, based on the load-balancing analysis, are given in the appendix. An 8-step design procedure is illustrated by 3 examples: (1) a oneway 7-1/2-in. roof slab weighing 94 psf and carrying a live load of 75 psf, (2) an 8-in. slab supported on 4 walls to be posttensioned in 2 directions for a live load of 100 psf, and (3) a 7-1/2-in. flat plate weighing 94 psf and carrying a live load of 100 psf. (USBR) W69-01423

### STRENGTH AND ELASTIC PROPERTIES OF CONCRETE IN FLAMING GORGE DAM,

Bureau of Reclamation, Denver, Colo

K. B. Hickey.

Bur Reclam Rep No C-1139A, July 1968. 23 p, 9

Descriptors: Concrete, Compressive strength, Poisson ratio, Pozzolans, Concrete control, Elasticity \*Concrete dams, \*Concrete testing, Concrete technology, \*Mass concrete, Laboratory tests, Concrete mixes, Age, Cores.

Identifiers: \*Concrete properties, Flaming Gorge Dam (Utah), Colorado River Storage Project, Longtime tests.

Results of load tests performed at 6 mo and 1, 3, and 5 yr on cores drilled from the mass concrete in Flaming Gorge Dam indicate good concrete in the structure. This study is part of a series in the Bureau of Reclamation's 20-yr evaluation of strength and elastic properties of concrete in various dams. Some findings, based on tests of 142 cores, are: (1) average 5-yr compressive strength of interior concrete, containing approximately 2 sacks of cement and 90 lb of calcined shale pozzolan per cu yd, is 3640 psi (258 kg per sq cm); (2) 5-yr strength of exterior concrete with 3-1/3 sacks of cement per cu yd is 4700 psi (330 kg per sq cm); (3) strengths of both concretes increase slightly with age; (4) average 5-yr compressive modulus of elasticity of the concretes is 4.0 million psi (280 thousand kg per sq cm); and (5) modulus of exterior concrete decreases slightly with age, while modulus of the interior material increases slightly with age. Cement efficiencies, coefficient of variation of strengths, and Poisson's ratios are discussed. (USBR) W69-01446

### **DETENTION AND PREVENTION OF FOUNDA-**TION UPLIFT FROM PRESSURE GROUTING,

Resources Agency, Sacramento, Calif. Robert J. Akers.

Tech Memo No 30, Dep Water Resour, State of Calif, Mar 1968. 8 p, 2 fig.

Descriptors: \*Grouting, \*Uplift pressures, Displacements, Tiltmeters, Foundations, Extensometers, Strain gages, Instrumentation, Surveying, Cracking, \*Dam foundations.
Identifiers: Uplift gages, \*Grouting pressure.

Detecting foundation displacement during grouting and determining the pressures involved are impor-tant in a successful grouting program. Use of resultant data will permit grouting at the highest safe pressure. Three methods of detecting foundation uplift from excess grouting pressures are: (1) precise leveling surveys, (2) the use of tiltmeters, and (3) the use of displacement gages or extensometers. These methods depend on the assumption that subsurface (foundation) movement will be evident on the surface, or with an extensometer, will cause displacements between the surface and in-hole reference points. A gage-alarm extensometer-type instrument developed by the Calif State Department of Water Resources is described. Criteria considered were: (1) instantaneous response to displacement, (2) adequate accuracy, (3) audible and visual alarm system actuated by a predetermined displacement, (4) ease of installation, (5) ruggedness and portability, and (6) low cost. (USBR) W69-01463

## 8G. Materials

# CORROSION AS A PRIMARY CAUSE OF CAST-IRON MAIN BREAKS,

Hinchman Co. Detroit, Mich.

John H. Fitzgerald, III.

Amer Water Works Ass J, Vol 60, No 8, pp 882-897, Aug 1968. 16 p, 10 fig, 35 ref.

Descriptors: \*Water pipes, Water supply systems, \*Pipelines, Cathodic protection, Pipes, \*Cast iron, Corrosion, \*Corrosion, control. Thickness, \*Corrosion control,
Protective Corrosion. Metallurgy, Backfills. coatings. Bibliographies, Electrical resistivity, Direct currents, Costs.

Identifiers: Galvanic corrosion, Underground corrosion, Ductile cast iron, Gray cast iron, \*Cast iron pipe, Soil resistivity, Corrosion tests.

The majority of breaks in cast iron water mains occur at locations where the pipe wall has been weakened. Weakening results from graphitic corrosion of cast iron, and although failure may be due to stress, the direct cause is corrosion. The corrosion process is reviewed and data are cited to show the relation between breaks and known corrosion phenomena. Recommendations for corrosion control and reduction of main breaks are discussed. Corrosion control may not pay off in the first 5 to 10 yr; savings from corrosion control are significant in water systems designed to last 100 yr. Eliminating the majority of breaks reduces maintenance expense, traffic delays, and customer ill will. Corrosion control is a management responsibility and is essential to the efficient long-term performance of a piping system. (USBR) W69-01429

### PLASTIC MEMBRANES REPAIR DAMS,

C F Groner

Energy Int, Vol 5, No 8, pp 16-18, Aug 1968. 3 p, 4

Descriptors: \*Impervious membranes, \*Repairing, Maintenance, Operation and maintenance, Concrete, Concrete structures, \*Concrete dams, Epoxies, Deterioration, Leakage, \*Plastics, Membranes, Glass fibers, Bituminous materials, Foreign construction, Materials, Mortars.

Identifiers: Polyesters, Polyvinyl chloride, Norway, Dam facings.

Various polyester and epoxy materials have been used to repair dams in Norway during the last 5 yr. Nomeland Dam, a 28-m high and 140-m long gravity structure, developed substantial leaks, especially along numerous construction joints. Repair operations consisted of cleaning the upstream face with steel brushes and scrapers, patching surface irregularities with cement mortar mixed with polyvinyl chloride, and applying a built-up membrane of polyester and fiberglass fabric. Repairs of an inverted arch concrete intake structure of the Tinfos hydroelectric project are described. The shutdown schedule would not permit complete drying of the concrete, restricting selection of materials to epoxy-type plastics. The membrane material selected (bituminous mortar mixed with epoxy) does not harden into a brittle membrane, remaining reasonably pliable after curing. (USBR) W69-01434

## THEORY AND PRACTICE OF PLASTIC PIP-

Mooney Brothers Corp., Little Falls, N. J.

Philip A. Schweitzer. Air Cond, Heat Vent, Vol 65, No 5-9, pp 41-56, 45-51, May-Sept 1968. 23 p, 14 fig, 47 tab.

Descriptors: \*Water pipes, Pipe fittings, \*Pipelines, \*Plastic tubing, Valves, Polyethylenes, Epoxies, \*Pipes, \*Plastics, Reinforcing, Welding, Thermoplastics, Corrosion, Design criteria, Design data, Materials, Joints, Supports, Asbestos.

\*Fiberglass Identifiers: Corrosion resistance, plastic pipes, \*Plastic pipes, Reinforced plastics, Glass reinforced plastics

Plastic piping materials are reviewed to provide information and data on the advantages of the latest plastic piping materials. The review includes: design criteria, pipe dimensions, pipe support, field fabrication and jointing methods, valves, and ac-cessory equipment. Characteristics and design data are discussed for polyvinyl chloride, polyvinyl dichloride, polypropylene, vinylidene fluoride, polyethylene, chlorinated rubber, and fiber-reinforced plastic pipe. Reinforced plastic pipes include glass fiber-reinforced polyester, blue asbestos-reinforced phenolic resin, blue asbestosreinforced epoxy, and glass fiber-reinforced epoxy. Glass fiber and asbestos are combined with polyester and epoxy to produce piping systems that will withstand high pressures and temperatures. (USBR) W69-01439

#### A CATIONIC WATER-BORNE SOIL SEALANT, Armour Industrial Chemical Co., Chicago, Ill. Jack N. Dybalski.

Symp New Uses for Asphalt, Amer Chem Soc 156th Annu Meet, Atlantic City, N J, Sept 1968. 13

Descriptors: \*Asphalt, Bituminous materials, \*Linings, \*Canal linings, \*Emulsions, Reservoirs, Irrigation canals, Toxicity, \*Seepage, Hydraulic structures, Seepage losses, Permeability, Adsorption, Soils, Operation and maintanance, Fish. Identifiers: \*Cationic asphalt emulsions, Surfac-tants, \*Soil sealants, \*Underwater canal sealing, Seepage control.

Many materials have been used for lining hydraulic structures, including concrete, asphalt hot mixes, asphalt-based prefabricated panels, buried asphalt membranes, clay, and a variety of plastic and elastomeric films. Each of these materials requires a laborious construction method and a relatively dry, water-free area for installation. These materials are either too costly or involve drying up the structure and time-consuming installation. factors point to the need for a waterborne soil sealant which, for speed and convenience, can be added directly to the water to seal the underlying soil. Laboratory and field work during the past 10 yr have shown the superior properties of cationic asphalt emulsions. These properties include a high affinity for almost all surfaces and the ability to strongly adhere to soil particles in the presence of water. Toxicity studies indicate that the sealant is nearly nontoxic by ingestion and nonirritating to ocular and skin tissue. The sealant acts as a physical toxicant to fish by sealing the gills, suggesting a safe method for removing trash fish and snails. (USBR) W69-01440

## LABORATORY AND FIELD INVESTIGATIONS OF PLASTIC FILMS AS CANAL LINING MATERIALS OPEN AND CLOSED CONDUITS SYSTEMS PROGRAM,

Bureau of Reclamation, Denver, Colo.

M. E. Hickey. Bur Reclam Rep No ChE-82, Sept 1968. 47 p, 5 fig, 14 tab, 16 photo, append.

Descriptors: \*Canal linings, Materials, \*Buried Descriptors: \*Canal linings, Materials, Duffed membranes, \*Impervious membranes, Flexible linings, Soil compaction, Vinyl plastics, Laboratory tests, \*Polyethylenes, Canal seepage, Subgrade, Irrigation canals, Earth materials, Field investigations, Ponding tests, Cutoffs, \*Lower cost canal linings, Plastics.

Identifiers: \*Open and Closed Conduit System Project, Seepage control, \*Polyvinyl chloride, \*Plastic

### Field 08-ENGINEERING WORKS

### Group 8G-Materials

Accelerated laboratory testing and field performance evaluations of polyvinyl chloride (PVC) and polyethylene plastic film indicate that these materials can be used satisfactorily as buried membrane linings. Both materials must be compounded by the manufacturer specifically for canal lining purposes to ensure longtime service. Neither material is suitable as exposed lining and must be protected by a minimum of 1 ft earth cover. Laboratory analysis of PVC lining after 7 yr service and polyethylene lining after 4 yr service indicates change in these materials. PVC and polyethylene plastic membrane linings in use for 10 yr are giving excellent service. These linings are low cost and easy to install, requiring a minimum of equipment and skilled labor. Short-term laboratory tests on newer ethylene vinyl acetate copolymer and chlorinated polyethylene plastic films indicate that these materials have possibilities as canal linings. Continued testing of these plastics is necessary to ascertain possible advantages over PVC and polyethylene linings. (USBR) W69-01447

### DEVELOPMENT AND USE OF PRESTRESSED STEEL FLEXURAL MEMBERS.

Proc Amer Soc Civ Eng, J Struct Div, Vol 94, No ST9, pp 2033-2060, Sept 1968. 26 p, 12 fig, 55 ref,

Descriptors: \*Beams, \*Prestressing, \*Girders, Structural steel, Steel, Safety factors, \*Structural members, \*Flexural strength, Bibliographies, Composite structures, Bending moments, Tensile stress, Stressing cables, Stess, Stress-strain curves, Trusses, Design criteria, Structural design, Structural engineering.

Identifiers: \*Prestressed steel, Hybrid beams, Prestressing systems, Composite beams, I-beams.

Prestressed steel enables the designer to achieve a greater elastic range than is possible for an identical nonprestressed member. This extended range enables a prestressed steel member to resist relatively large overloads without suffering permanent distortion. Prestressing is a means of efficiently utilizing various strength steels in builtup beams or girders, so that significant savings in weight and depth of members can be achieved. Savings are realized without reducing the factor of safety against yielding for any of the steels, but the margin of safety against the plastic mechanism is reduced. W69-01450

## EFFECT OF RUST AND SCALE ON THE BOND CHARACTERISTICS OF DEFORMED REIN-FORCING BARS.

West Virginia Univ., Morgantown; Corps of Engineers, Fort Benning, Ga.

E. L. Kemp, F. S. Brezny, and J. A. Unterspan. J Amer Concr Inst, V 65, No 9, pp 743-756, Sept 1968. 14 p, 11 fig, 6 tab, 11 ref.

Descriptors: \*Reinforced concrete, \*Reinforcing steel, \*Deformed bars, Reinforcing, \*Mill scale, Specifications, Concrete testing, Bars, Design criteria, Materials testing, Concrete, \*Concrete technology, Oxidation, Corrosion, Stress.
Identifiers: \*Bond tests, Bond strength, Rusting,

Test results

Bond characteristics of ASTM A 432 reinforcing bars were investigated under a wide range of scale and rust conditions. The bar surface condition was the principal parameter studied. Test results indicate that bond characteristics of deformed reinforcing bars meeting ASTM A 305 specifications are not adversely affected by varying degrees of surface rust or ordinary mill scale, provided the bar meets minimum ASTM weight and deformation height requirements. Deformation dimensions appear to govern bond characteristics of rusty bars in that these bars behave similarly to companion asrolled bars. Current bond requirements seem conservative, especially for smaller bars, because of the 800-psi maximum stress limit. Concrete

strength appears to control overall bond behavior, particularly slip and deformation, more than the surface condition of the bar. (USBR)

## 8H. Rapid Excavation

CHANGES IN THE PROPERTIES OF SETTLED LOESSIAL SOILS WITH DEPTH AFTER COM-PACTION OF THE SOILS BY WETTING AND THE EFFECTS OF BLASTING,

For primary bibliographic entry see Field 08D For abstract, see W69-01409

### ANALYSIS OF EXPLOSIVE EXCAVATION,

State Scientific-Research Institute for Special Planning, USSR. R. Ia. Strausman.

Trans. from Vzryvnoe delo, Sb 61/18, pp 175-187. 1966. Bur Reclam Transl 774, Oct 1968. 20 p, 8

Descriptors: \*Explosions, Explosives, \*Excavation, \*Cratering, Canals, Craters, Foreign design practices, Mathematical analysis, Design tools, Data reduction, Field data, Design standards, \*Charges

(Explosives), Rock excavation, Soils. Identifiers: USSR, \*Explosive excavation, Canal construction.

A Soviet research institute, using correlation analysis methods, examined records from actual explosions carried out in the USSR from 1938-1963, to determine the dynamics of excavating charges and to refine design methods of longitudinal structures such as canals. The analysis was limited to explosions having a single-row placement of charges at depth to 20 m in 3 classes of soils: sandy clays and gravels; clays; and rocks such as limestones, sandstones, and slates. Results showed that: (1) M M Boreskov's formula for determining charge weight is justified for cratering factors (n) from 1 to 3; (2) this formula is accurate for row charges in channel excavation when n = 2 to 3, without a correction factor; (3) this factor, based on relations established by the analysis between various parameters in the formula, allows computing rowcharge explosive excavation for channels when n ranges from 1 to 3; (4) the experimental study of geometric shapes and dimensions of craters determined the differences between true and apparent craters and made possible the development of a formula for computing the apparent depth of excavation; and (5) best results were obtained by using charges with n equal to or greater than 2.5 (USBR) W69-01465

### 09. MANPOWER, GRANTS AND FACILITIES

### 9A. Education )Extramural(

WATER RESOURCES RESEARCH INTERESTS IN THE SENIOR COLLEGES AND UNIVERSI-TIES OF NORTH CAROLINA.

North Carolina University, Chapel Hill.

Water Resour Res Inst Rep 3, Univ N Car, Apr 1967. 22 p. OWRR Project A-999-NC.

Descriptors: \*Water resources, Water Resources Research Act, Grants, Manpower, Universities, North Carolina, Research facilities, \*Scientific per-

The water resources research interests of faculty members of the senior colleges and universities of North Carolina are summarized. Many of the scientists listed in this report, while presently devoting their full attention to nonwater related research, have indicated sufficient interest in water resources to suggest their possible involvement in this field. This represents a reservoir of potential research capability which can be drawn upon as circumstances permit.

### WATER RESOURCES CENTER )GA. INST. OF TECHNOLOGY(.

State of Georgia, Atlanta.

17 Ga Code Ann, Secs 17-401 to 17-403 (1967).

Descriptors: \*Georgia, Legislation, \*United States, Research development, Training, \*Water resources, \*Universities, Local governments, Condevelopment, Training, \*Water tracts, Grants, Inter-agency cooperation.
Identifiers: Georgia Institute of Technology.

The Georgia Institute of Technology is empowered to operate a center for research and training in relation to water and resources affecting water. The findings and recommendations arising from such research are to be published or otherwise made available. The Center is authorized to use federal funds made available by grants and to use matching federal funds for expenses of specific water resources research projects. The center can enter into contracts or agreements with other colleges or universities, the federal government, local government units of this state and other individuals for specific research relating to water problems. (Childs-Fla) W69-01301

## 9D. Grants, Contracts, **AND Research Act Allotments**

### FEDERAL GRANTS FOR CLEAN WATER.

Fed Water Pollut Contr Admin Publ CWA-6, Jan 1968. 12 p.

Descriptors: \*Grants, Research and development, \*Contracts, Planning, \*Water pollution control, Legislation, Application methods, Water resources development.

Identifiers: \*Federal Water Poll Cont \*Research and dvlpmt centers, \*Clean Water Restoration Act.

Each of the grant programs administered by the Federal Water Pollution Control Administration is described in this booklet. The purpose, financial basis, method of distribution, matching provisions, who may receive federal aid, application procedure and legal basis is given for each of the following grant programs: (1) Grants for comprehensive basin planning, (2) Training grants and research fellowships, (3) Research, development and demonstration grants and contracts, (4) State and interstate agency program grants, (5) Grants for waste treatment works construction, and (6) Appalachian regional development grants for waste treatment works construction. (S. Mayer-FWPCA) W69-01240

ANNUAL REPORTS OF THE CUMBERLAND RIVER BOARD, THE NORTHUMBERLAND AND TYNESIDE RIVER BOARD, AND THE WEAR AND TEES RIVER BOARD FOR THE YEAR ENDED 31ST MARCH, 1964. Cumberland River Board, the Northumberland and

Tyneside River Board and the Wear and Tees River

90 pp, 15 graphs, 8 tables, 3 plates; 58 pp, 2 gr; 58 pp, 4 pl, 1 map.

Descriptors: \*Storm runoff, \*Water pollution, \*Waste dilution, Standards, \*Overflow.

These reports contain information on water resources, fisheries, and prevention of pollution, including the quality of water and sources of pollution in individual rivers; standards for effluents from sewage works, storm-sewage tanks and overflows, individual properties, farms, and trade premises. In the Wear and Tees area, serious pollution, with obvious pollution by crude sewage, was observed in a small stream following a heavy storm, showing that overflows of storm-sewage are not adequately diluted by the increasing flow of the receiving stream when the stream is small and the storm-sewage overflow setting is low. W69-01508

TWELTH AND THIRTEENTH ANNUAL RE-PORTS BEING FOR THE YEARS ENDED 31ST MARCH, 1963 AND 31ST MARCH, 1964. Lancashire River Board.

102 pp and 106 p respectively.

Descriptors: \*Storm runoff, \*Overflow, \*Water pollution

pollution. Identifiers: \*Storage tanks, \*Urban drainage.

These reports contain information on water resources and the prevention of river pollution, both of which were affected by the severe cold weather early in 1963. One of the principal problems in the industrialized parts of the area is the pollution caused by storm sewage overflows, and to alleviate pollution caused by the 'first flush' of storm sewage overflows the Board has suggested the provisions of holding tanks. An investigation was begun into the factors causing growth of Sphaerotilus natans in a river below the outfall from a paper mill where suspended solids content and BOD of the effluent are vary low. Other special investigations included studies on the Wyre estuary to determine the composition and rate of discharge of effluents which could be considered unlikely to harm migratory fish. The criteria used in assessing the degree of pollution of a river or stream are summarized.

W69-01509

TWELFTH AND THIRTEENTH STATUTORY ANNUAL REPORTS, YEARS ENDED 31ST MARCH, 1963 AND 31ST MARCH, 1964. Trent River Board.

116 pp, 2 maps, 6 plates.

Descriptors: \*Water pollution, \*Storm runoff, \*Overflow, Surface runoff. Identifiers: \*Storm sewers, \*Suspended solids.

These reports of the Trent River Board contain sections on water resources, fisheries, and prevention of river pollution, including information on water quality (which is interpreted in relation to the discharge of polluting waste waters and the effects of severe cold weather); remedial action; and standards for effluents. Chemical data obtained in river surveys are appended and are correlated with biological characteristics as represented by the Biotic Index. The principal cause of fish mortalities was de-oxygenation of river water due to prolonged ice and snow cover or to the operation of stormsewage overflows following periods of dry weather; the first flush of water discharged from surface water sewers after a dry period is also highly polluting and contributes to de-oxygenation. During the first few days of April each year the rivers Tame and Trent carry in suspension large quantities of detached sewage fungus which, under conditions of low flow, settle out with other suspended matter and tend to become black in colour; following rainfall and increased flow in the rivers, this material is scoured out into suspension and exerts a considerable oxygen demand thus contributing further to the de-oxygenation. The cold winter of 1963 inhibited nitrification at most of the sewage works; this caused increased concentrations of ammonia in the receiving waters at a period when flow was minimal and the frozen surface of the rivers prevented aeration, and is considered to be the cause of elimination of fish in a stretch of the river Soar. Prevention of Pollution By-laws became operative in November 1962. W69-01510

# 10. SCIENTIFIC AND TECHNICAL INFORMATION

WATER RESOURCES OF VIRGINIA: AN IN-VENTORY OF PRINTED INFORMATION AND DATA.

Virginia Polytechnic Institute, Blacksburg. Frederick E. McJunkin, and William R. Walker. Water Resources Res Center Rep, Virginia Polytech Inst, Mar 1966. 109 p, 1,010 ref, append. OWRR Project A-999-Va.

Descriptors: \*Bibliographies, Water resources, Water resources research act, Water resources development, Virginia, Publications, Technology, Research and development.
Identifiers: Inventories, Technical papers, Reports.

An inventory of published information and data on the general subject of water resources in Virginia. The publication is divided into 2 basic indexes: an author index and a subject and geographic index. Publications prepared for an agency but listing individual authors have been listed under the author index. Papers prepared for agencies which do not identify the author are indexed according to agency name. Listing of authors and subjects is alphabetical. Where one author has several listings, these are chronologically ordered with a few exceptions, e.g. U S Army Corps of Engineers, wherein ordering is alphabetical by the name of the body of water concerned. An appendix enumerates addresses of state and federal government organizations concerned with research, planning, development, and use of water or water related resources in Virginia. The principal coverage has been limited largely to materials dealing wholly or in part with aspects of water resources with specific reference, geographical or otherwise, to Virginia. Some listings from related fields are also included. W69-01231

A REVIEW OF THE LITERATURE OF 1966 ON WASTE WATER AND WATER POLLUTION CONTROL.

For primary bibliographic entry see Field 05D. For abstract, see . W69-01514



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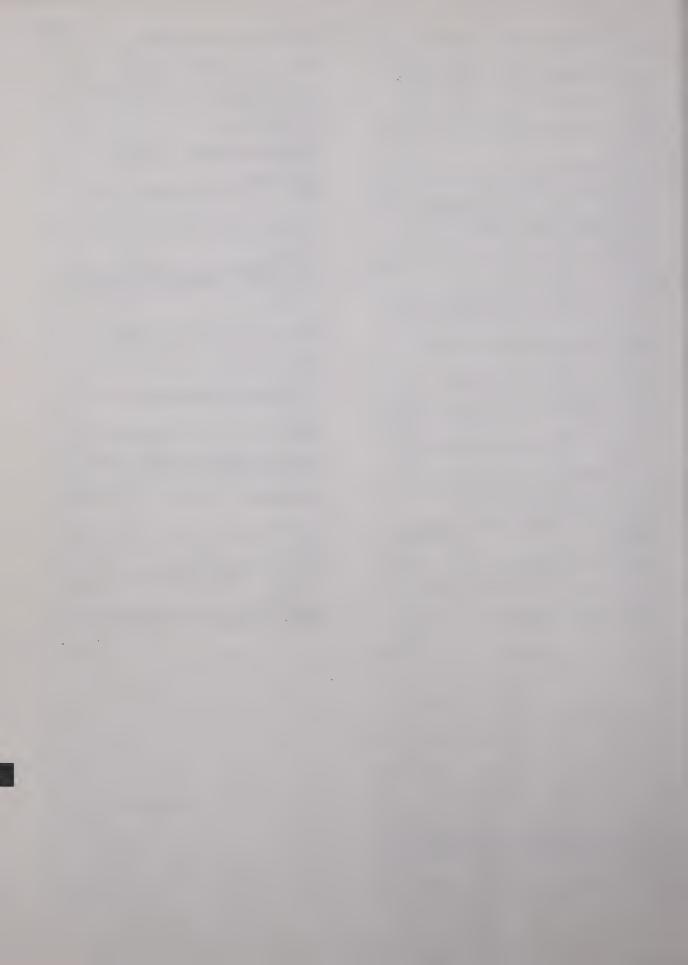
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